

mance, it will be necessary to create a more sophisticated interface between plan assessment and refinement. Many factors influence overall planning performance: speed of assessment, the tightness of probabilistic bounding calculations, and the type of search control guidance that the assessor can provide.

7 Related Work

Related work can be found in several areas: other AI approaches to probabilistic planning, robotic motion planning, decision models, and classical planning and plan evaluation techniques.

7.1 Probabilistic planning

Several early pieces of work [22, 42] cast planning in probabilistic or decision-theoretic terms, but did not provide concrete representations or algorithms to solve the problem. More recent work divides according to how the planning problem is defined, and how states and operators are represented.

Markov decision processes Several research efforts (*e.g.* [34, 12]) adopt a planning model based on fully observable Markov processes. There are two main differences between this work and ours. First of all, the algorithms operate directly on the state space rather than on its component propositions, and the actions are represented directly as probabilistic mappings from states to states—the algorithms do not manipulate symbolic action descriptions. (Koenig shows a translation from STRIPS-like symbolic operators to the transition-matrix representation, but the solution algorithm does not use the symbolic representation.)

A more important distinction is that these approaches build a *reaction strategy* rather than a plan. A reaction strategy is a policy that dictates the action the agent should take for each state in the state space. A plan, on the other hand, is a sequence of actions that the agent executes without regard to the state. The assumption behind the Markov decision process approach is that the agent will always *know* what state it is in while it is executing its strategy—in other words, that it will be provided with accurate and immediate information about the new world state every time it executes an action.

A plan embodies the opposite assumption—that the agent will get *no* additional information about the world at execution time—so it might as well plan what to do ahead of time. Recent extensions to BURIDAN [16, 15] take a middle ground: that information is available at execution time, but it has to be explicitly gathered, and is potentially inaccurate.

Symbolic planning approaches Farley [21] proposes a similar action representation, though he attaches probabilities directly to postconditions rather than to sets of postconditions. His planning algorithm is linear and “progressive”: it starts from the initial state (assumed unique) and builds linear plan sequences, always adding steps to the end of the plan.

Mansell [37] proposes a strategy in which the planner attacks each possible initial world state in isolation (beginning with the most likely), and uses a deterministic hierarchical planning algorithm to build a plan for each. After these plans are built, the algorithm tries to merge the distinct plans. This approach is similar to the “robustification” approach proposed by Drummond and Bresina [17]. BURIDAN can be forced to operate in this mode

(by allowing it to link to only a single initial state at a time), though the advantage of postponing the merging process to the end of the planning episode is not clear.

Preliminary work by Goldman and Boddy [24] attacks a similar problem: building plans that are likely to achieve the goal, where likely is defined in terms of a threshold. They develop an extended action and plan representation that incorporates observations and contingencies, so a comparison to C-BURIDAN [16, 15] is more apt. Their approach to planning is quite different from ours, however. They use a deterministic planner (based on CNLP [52]) and they manage uncertainty using an external probabilistic network model to assign probabilities to propositions with unknown truth values. Splitting the problem into a deterministic planner and an external mechanism for managing uncertainty is more similar to Mansell's approach than to ours.

7.2 Robotic motion planning

Robotics researchers have also considered the problem of planning with actions whose effects are uncertain. For example, Lozano-Perez, Mason and Taylor [36] introduced a backward chaining strategy (LMT) for motion planning given sensing and control uncertainty which has been extended by Erdmann [18] and others. An interesting connection between these approaches and ours is the analogy between the use of compliant motion and conditional effects for reducing uncertainty, but there are more differences than similarities. Most obvious is their emphasis on geometry. Second, they model sensing actions (but see Brost [4]) which are omitted from BURIDAN, though the extensions cited above address that deficiency. Third, their *preimage* notion of uncertainty bears more of a resemblance to a possible-worlds model of incomplete information than our probabilistic model. Fourth, their focus is on planning strategies that are guaranteed to succeed despite uncertainty (as are the Markov-process approaches above); in contrast, BURIDAN plans need only have probability of success that exceeds a user specified threshold. Donald's work [14] extends the basic LMT paradigm to handle incomplete knowledge of the world's geometry and to provide error detection and recovery.

7.3 Graphical decision models

Work on graphical probabilistic and decision models (see Howard [32], Pearl [44], or the overview in [11, Chapter 7]) also deals with decision making and planning problems, but has focused more on solving a given probabilistic or decision model whereas our algorithm interleaves the process of constructing and evaluating solutions. The problem modelled by an influence diagram involves choosing options from a fixed set of choices rather than constructing a course of action dynamically from a goal description.

Recent work, however, has recognized the importance of interleaving the model-construction and the model-solution problems, both in general [25] and as applied to the planning problem in particular [51]. Also see [3] for a survey of work in this area.

7.4 Probabilistic temporal reasoning

The representation for the NETWORK algorithm is similar to the network proposed by Dean and Kanazawa [13].

As we discussed in Section 5, a totally ordered plan can be formulated as a probabilistic network allowing assessment to be performed using standard propagation techniques [44]. Although our experiments with the NETWORK assessment algorithm showed that the Jensen clustering algorithm is probably inappropriate for problems of this type, other approaches might be more suitable. Dean and Kanazawa [13] advocate stochastic simulation techniques, but these lack convergence bounds and thus sacrifice soundness and completeness. Recent results [9] also suggest that an approximation algorithm may not be more effective than an exact method.

7.5 Action representation and plan evaluation

Our action representation comes from Hanks's work [29, 30, 28] on probabilistic projection. Chrisman [6] develops an action representation and projection rule for planning under uncertainty, and Martin and Allen [38] develop statistical techniques to gather probabilities like the ones our algorithm uses. None of this work directly addresses the problem of plan generation.

The QUERY algorithm is described in [30, 28]; Drummond [17] presents an alternative algorithm for a similar problem.

Haddawy and Hanks [26] motivate building a planner such as BURIDAN. They provide a framework for constructing a restricted class of utility functions for use by a decision-theoretic planner and show circumstances under which determining whether one plan dominates another reduces to establishing bounds on the probabilities of particular propositions at particular times, which is precisely what our plan assessment algorithms compute. Doyle and Wellman [57] discuss the general problem of modular specification of a planner's objectives in a decision theoretic framework. They exploit multiattribute utility theory to devise techniques for composing separate preference specifications.

7.6 Classical planning

Dealing with state-dependent effects is an essential requirement for any useful probabilistic planner. In this regard BURIDAN can be seen as generalizing the work on planning with deterministic conditional effects, *e.g.* in [47, 7, 50]. A deterministic form of confrontation is used in UCPOP [50]. Pednault's ADL language allowed for disjunctive effects and he used them to solve a simple symbolic version of the "Bomb in the Toilet" example [46] which we extended in Section 6. However, no implementations of ADL (*e.g.*, Pedestal [40] and UCPOP [50]) have implemented the functionality of disjunctive effects, which BURIDAN does.

8 Conclusions

BURIDAN represents a significant step in the development of practical algorithms for probabilistic planning. While much work remains to be done, BURIDAN provides a profitable basis for future study.

8.1 Implementation

BURIDAN is fully implemented in Common Lisp and has been tested on many examples including the ones presented in this paper. The implementation is robust (*e.g.* successfully searches tens of thousands of plans). Although the code has not been optimized for speed or search control, we feel that it is a solid foundation for future research. In addition, it would be excellent in an instructional setting. Send mail to `bug-buridan@cs.washington.edu` for instructions on acquiring BURIDAN source code via anonymous FTP.

8.2 Summary

In this paper we've reported on several significant advances:

1. We have extended the classical planning representation to handle uncertainty in the initial world state (via probability distributions over world states) and in the effects of actions (via mutually exclusive and exhaustive triggers paired with STRIPS-like effects).
2. We provided a precise probabilistic semantics for our representation. Execution of an action causes a transition from one state distribution to another.
3. We described BURIDAN, an implemented algorithm for probabilistic planning, and proved that it is both sound and complete.
4. We compared the efficiency of the FORWARD, QUERY, NETWORK and REVERSE probabilistic assessment algorithms both analytically and empirically. We characterized the strengths of each algorithm, and observe that none of the four is clearly dominant.
5. We noted that the fastest assessor does not necessarily lead to the fastest planner and explain why. We argued that the refine-assess architecture could be improved by allowing the plan assessor to provide more guidance to the plan refiner. As a simple example of this strategy, we demonstrated that considerable speedup is possible when the assessment algorithm returns action-ordering information in addition to its probability calculation.

8.3 Future work

We hope to extend BURIDAN in many directions. From a purely practical perspective, BURIDAN's functionality is limited by its propositional representation, so we plan to implement a lifted [53, 39] version using the codesignation constraint code developed for UCPOP

[50]. The major challenge of this endeavor is devising an efficient means for handling the disjunctive bindings that could result when a lifted trigger condition is supported by multiple causal links from different ground consequences.

Another extension would allow BURIDAN to handle probabilistic exogenous events and incorporate the model of sensing and information advanced in the UWL language [20]. We'd like to integrate Peot and Smith's [52] algorithm for generating conditional plans with this framework and to consider interleaved planning and execution [2, 43, 35] as well. Recent work on C-BURIDAN [16, 15] has addressed some of these issues.

We also hope to introduce an explicit temporal model (perhaps using ideas from ZENO [48, 49]) so we can represent deadline goals. This would allow us to consider integrating our probabilistic plan refinement algorithm with the utility model presented in [26].

On the algorithmic side we have just begun to explore methods of controlling the search for good plans. As Section 6 demonstrates, there are a number of important architectural issues which deserve exploration. We hope to develop a more sophisticated refine-assess interface so that the computational expense of plan assessment pays dividends by guiding subsequent refinements. We also wish to evaluate additional assessment methods (*e.g.* incremental assessment, stochastic simulation, *etc.*) and their relationship to plan refinement.

A Proof of Completeness

Theorem 2 (Completeness) *Let $\Delta = \langle \tilde{s}_I, \mathcal{G}, \tau, \Lambda \rangle$ be a planning problem and let $\langle A_i \rangle_{i=1}^N$ be an essential solution (i.e., no proper subsequence is also solution) of Δ . Then there exists a sequence of nondeterministic choices such that $\text{BURIDAN}(\Delta)$ will return $\langle A_i \rangle_{i=1}^N$.*

To finesse issues of search control, we use $\langle A_i \rangle_{i=1}^N$ as an oracle to guide the construction of the partially ordered plan; McDermott [40] refers to this technique as a *clairvoyant algorithm*. Our implementation uses exhaustive search to ensure that every sequence of nondeterministic choices is eventually considered.

We first establish a useful lemma. Recall that plan data structures contain a set of subgoals: $\mathcal{S} = \{\dots, \mathbf{p} @ A_i, \dots\}$. We introduce one new piece of terminology to concisely refer to the result of executing action subsequences: let \mathcal{SD}_j^k be the state distribution produced by executing $\langle A_i \rangle_{i=j}^k$ in \mathcal{SD} . If $k < j$ then $\mathcal{SD}_j^k \equiv \mathcal{SD}$.

Lemma 3 *Let $\Delta = \langle \tilde{s}_I, \mathcal{G}, \tau, \Lambda \rangle$ be a planning problem and suppose that a call to $\text{BURIDAN}(\Delta)$ yields values $\langle \mathcal{A}, \mathcal{O}, \mathcal{L}, \mathcal{S} \rangle$ such that $\langle A_i \rangle_{i=2}^N$ is a consistent topological sort of \mathcal{A} (excluding the initial and goal actions). Let \mathcal{E} be an expression composed of literals all of which are subgoals in \mathcal{S} for the same action A_m , and let A_1 be some action not in \mathcal{A} . If there exists $l < m$ such that*

$$P[\mathcal{E} | \mathcal{SD}_1^l] > P[\mathcal{E} | \mathcal{SD}_2^1],$$

then REFINE can make a sequence of nondeterministic choices that will add A_1 to \mathcal{A} .

Proof: Our proof is by induction on m .

Base Case: $m = 2$.

In this case $l = 1$ and we assume that $P[\mathcal{E} | \text{EXEC}(A_1, \mathcal{SD}_1^1)] > P[\mathcal{E} | \mathcal{SD}_2^1]$, which is equivalent to $P[\mathcal{E} | \text{EXEC}(A_1, \mathcal{SD})] > P[\mathcal{E} | \mathcal{SD}]$.

By definition, the only way that the probability of \mathcal{E} can be greater after executing A_1 is if doing so increases the probability associated with the states containing \mathcal{E} . But the only way that this could happen is if A_1 has an consequence containing \mathbf{p} for some $\mathbf{p} \in \mathcal{E}$. But in that case REFINE Line 2.a could choose to add A_1 to the plan since $\mathbf{p} @ A_2 \in \mathcal{S}$.

Inductive Step: $m > 2$.

The inductive hypothesis guarantees that if there exists some $l < m - 1$ such that $P[\mathcal{E} | \mathcal{SD}_1^{l-1}] > P[\mathcal{E} | \mathcal{SD}_2^{l-1}]$ then A_1 can be added to the plan. We need to show that this holds for $l = m - 1$ as well.

Suppose that $P[\mathcal{E} | \mathcal{SD}_1^{m-1}] > P[\mathcal{E} | \mathcal{SD}_2^{m-1}]$. Three (exhaustive but non-exclusive) cases can explain this relationship:

1. The increase in the probability of \mathcal{E} happens *before* A_{m-1} is executed—in other words, $P[\mathcal{E} | \mathcal{SD}_1^{m-2}] > P[\mathcal{E} | \mathcal{SD}_2^{m-2}]$. But in that case the inductive assumption directly indicates that A_1 could be added.

2. The increase in the probability of \mathcal{E} occurs because including A_1 causes A_{m-1} to contribute additional probability mass to \mathcal{E} . Specifically, A_{m-1} contains a consequence $\langle t_i^{m-1}, \rho_i^{m-1}, e_i^{m-1} \rangle$ such that e_i^{m-1} makes some proposition p in \mathcal{E} true, and $P[t_i^{m-1} | \mathcal{SD}_1^{m-2}] > P[t_i^{m-1} | \mathcal{SD}_2^{m-2}]$. But then a nondeterministic choice in REFINE Line 2.a could choose this consequence to support p . So for every $q \in t_i^{m-1}$ a nondeterministic choice in REFINE Line 2.a could make $q @ A_{m-1}$ a subgoal as well, the inductive assumption applies to t_i^{m-1} , and A_1 could be added.
3. Finally, the increase in the probability of \mathcal{E} might occur because including A_1 causes A_{m-1} to contribute *less* probability mass to an consequence that makes \mathcal{E} *false*. Note that in this case \mathcal{E} must have non-zero probability before A_{m-1} is executed, *i.e.* $P[\mathcal{E} | \mathcal{SD}_2^{m-2}] > 0$. But if this is the case then for every proposition $p \in \mathcal{E}$ there must be some action A_i with a consequence ι that contains p , and REFINE Line 2.b could add causal links $A_i, \iota \xrightarrow{p} A_m$, for each such of them.

It must also be the case that some consequence in A_{m-1} tends to make \mathcal{E} false, and A_1 tends to make that consequence less likely. In other words, A_{m-1} must contain a consequence $\langle t_\kappa^{m-1}, \rho_\kappa^{m-1}, e_\kappa^{m-1} \rangle$ such that $\bar{p} \in e_\kappa^{m-1}$, where $p \in \mathcal{E}$, and furthermore $P[t_\kappa^{m-1} | \mathcal{SD}_1^{m-2}] < P[t_\kappa^{m-1} | \mathcal{SD}_2^{m-2}]$.

But in this case, REFINE would recognize the κ consequence of A_{m-1} as a threat and Line 3.c could *confront* the threat. Confronting the threat means that the literals in the triggers of all *non-interfering consequences* of A_{m-1} could be adopted as a subgoal in \mathcal{S} (Line 3.c.iii). Since Definition 1 states that an action's triggers are mutually exclusive and exhaustive, $P[t_\kappa^{m-1} | \mathcal{SD}_1^{m-2}] < P[t_\kappa^{m-1} | \mathcal{SD}_2^{m-2}]$ implies that the probability of at least one of A_{m-1} 's *non-interfering* triggers will have *greater* probability when A_1 is executed. But if so the inductive assumption is satisfied and A_1 could be added to the sequence. \square

We are now ready to tackle the main theorem. Since the proof is somewhat complex, we sketch the high level concept before delving into the details. The proof method is induction and (unsurprisingly) the induction step is the crux. We demonstrate that a sequence of nondeterministic choices exists which returns an N step plan for a planning problem Δ by constructing a *modified* problem which can be solved in $N - 1$ steps. Since the induction hypothesis states that BURIDAN can solve this easier problem, we need only show how the choices made for the modified problem lead to choices that solve Δ itself. Lemma 3 makes this (relatively) straightforward.

Proof (Completeness): Given a planning problem Δ and an essential solution $\langle A_i \rangle_{i=1}^N$, we need to show two things. First, that REFINE can make a sequence of nondeterministic choices resulting in a plan consistent with $\langle A_i \rangle_{i=1}^N$. Second, that the FORWARD assessor will recognize that plan as a solution. Our proof is by induction on N , the number of actions in the plan.

Base Case: $N = 0$.

If $N = 0$ then the goal is sufficiently likely without any actions being added: $P[\mathcal{G} | \mathcal{SD}] \geq \tau$. A call to BURIDAN will create the null plan for Δ and immediately call FORWARD for assessment. Since there are no actions in $\mathcal{A} - \{A_0, A_G\}$, FORWARD Line 3 returns the probability of the single total order consistent with this plan, which by assumption exceeds the threshold. BURIDAN calls TOTAL-ORDER and returns the empty sequence.

Inductive Step: $N \geq 1$.

The inductive assumption ensures that clairvoyant BURIDAN correctly generates solutions of the form $\langle A_i \rangle_{i=1}^m$ for $m < N$. We now show that BURIDAN finds a solution for N -action plans as well.

Let Δ' be the planning problem $\langle \text{EXEC}(A_1, \mathcal{SD}), \mathcal{G}, \tau, \Lambda \rangle$. By Definition 4, the length $N - 1$ action sequence $\langle A_i \rangle_{i=2}^N$ is an essential solution to Δ' . Clairvoyant BURIDAN(Δ') will therefore generate a partially ordered plan, $\mathcal{P}' = \langle \mathcal{A}', \mathcal{O}', \mathcal{L}', \mathcal{S}' \rangle$, such that $\langle A_i \rangle_{i=2}^N$ is a consistent topological sort. \mathcal{P}' is very similar to the plan that we are seeking, but its initial action is doing double duty, providing probability mass for propositions that \mathcal{SD} and A_1 provided collectively in the original solution.

Now consider the execution trace of all nondeterministic choices made by clairvoyant BURIDAN while constructing \mathcal{P}' for Δ' . We can use this trace, with some modifications, to guide BURIDAN toward a solution to the original problem Δ .

Since the only difference between Δ' and Δ occurs in the initial state distributions \mathcal{SD} and $\text{EXEC}(A_1, \mathcal{SD})$, we need to guide BURIDAN's choice only when it tries to create a link from the initial action, A_0' —otherwise, plan refinement can proceed as it did when \mathcal{P}' was generated. Recall that A_0' (the initial action of \mathcal{P}') corresponds to the state distribution $\text{EXEC}(A_1, \mathcal{SD})$. If \mathcal{P}' contains a link supporting p whose producing action is A_0' , then there exists an consequence of A_0 or A_1 that contains p . In that case we instruct BURIDAN to choose such an consequence and create a link from it.

Note that this argument guarantees that BURIDAN will add actions A_2, \dots, A_N to the plan (along with ordering constraints on them), but it does not guarantee that BURIDAN will add A_1 to the plan: \mathcal{P}' might not contain a link whose producer is A_0' . But recall that no proper subsequence of $\langle A_i \rangle_{i=1}^N$ is a solution, therefore

$$P[\mathcal{G} | \mathcal{SD}_1^N] > P[\mathcal{G} | \mathcal{SD}_2^N].$$

Since \mathcal{G} is a conjunction of propositions that have been adopted as subgoals in \mathcal{S} , Lemma 3 guarantees that there is a sequence of nondeterministic choices REFINE can make that will add A_1 .

At this point we have established that BURIDAN can add the right *actions* to \mathcal{A} , but we haven't yet guaranteed that it will add enough *ordering constraints* to \mathcal{O} . In particular we have not guaranteed that A_1 will be constrained to occur first in the plan. If BURIDAN fails to constrain A_1 to be the first action in the plan, then FORWARD will iterate over all total orders consistent with \mathcal{O} and one of these might achieve \mathcal{G} with probability less than τ , meaning that BURIDAN would fail to recognize the solution.

We can show that it is a contradiction to assume that *no* sequence of nondeterministic choices will cause A_1 to be ordered first in the plan. Let $m \geq 2$ be the smallest number such

that executing A_1 before A_m achieves the goal with some probability $\geq \tau$, while executing A_1 immediately *after* A_m achieves the goal with some probability $< \tau$. If so there must be a sequence of nondeterministic choices made by REFINE at Lines 2.a and 3.c that create a causal link whose producer is A_m and which is threatened by A_1 . But if that is the case, REFINE Line 3.a could demote A_1 by adding $A_1 < A_m$ to \mathcal{O} .

In summary, if $\langle A_i \rangle_{i=1}^N$ is an essential solution to a planning problem, then a sequence of nondeterministic decisions can cause BURIDAN to add each of actions A_1 through A_N to the plan, along with all relevant ordering constraints. FORWARD will return $\text{Min} \geq \tau$, and clairvoyant TOTAL-ORDER will return $\langle A_i \rangle_{i=1}^N$ which is a solution to Δ . \square

B The REVERSE Assessment Algorithm

REVERSE uses the plan’s causal links to evaluate a plan. The probability that a proposition holds when a particular action is executed can be estimated by traversing the link structure that provides causal support to the proposition. The idea is to traverse the links, constructing an *assessment expression*, a boolean combination of causal links, triggers, subgoals and ρ_i^i terms. Starting from the trigger of goal’s SUCCESS outcome, the assessment expression is incrementally transformed as follows:

- The assessment expression for the trigger of a consequence is the *conjunction* of the assessment expressions of the subgoals corresponding to the trigger’s conjuncts, conjoined with the consequence’s probabilistic term.
- The assessment expression for a subgoal is the *disjunction* of the assessment expressions for all the links supporting the subgoal. If a subgoal has no causal support then no transformation is made.
- The assessment expression for a link is the assessment expression of the trigger for the link’s producing outcome, conjoined with a conjunction of the assessment expressions of the subgoals of the safety condition associated with confronted threats.

These transformations are applied repeatedly until the expression is a boolean combination of only subgoals without causal support and probabilistic terms for the consequences that constitute the plan’s causal structure. This expression can then be evaluated directly. Table 7 precisely specifies the REVERSE algorithm.

REVERSE computes a lower bound on the probability of plan success. To understand this, note that main difference between REVERSE and the other algorithms is that whereas the others algorithms take into account *all* causal relationships inherent in the plan, REVERSE reasons about only those causal relationships explicitly represented in the plan’s link structure. There are therefore two ways in which a probability computed using causal links might differ from the value returned by the exact algorithms:

- There might be a action that produces a proposition that is required by a subsequent action, yet REVERSE has not installed a link between those two actions. In that case REVERSE may underestimate the proposition’s probability.
- There might be a threat to an existing link that has not been resolved yet by the refinement algorithm. In that case REVERSE may overestimate the probability of the link’s supported proposition.

We force REVERSE to produce a lower bound on probabilities by ignoring links that are threatened (see the PROD function in Table 7) and by leaving subgoals with no causal support untransformed (Line 2.b applies only if the subgoal has causal support). When a plan is refined so that all threats are resolved and all subgoals are supported in all possible ways, then REVERSE computes the same probability as the other assessment algorithms.

REVERSE(\mathcal{P})	
1. Initialize the assessment expression to t_α^G .	
2. Loop: Transform a term from the assessment expression as follows:	
a.	$t_i^i \Rightarrow \rho_i^i \wedge \bigwedge_{p \in t_i^i} p @ A_i$
b.	$p @ A_j \Rightarrow \bigvee_{A_{i,t} \xrightarrow{p} A_j \in \text{PROD}(p @ A_j)} A_{i,t} \xrightarrow{p} A_j \quad \text{if } \text{PROD}(p @ A_j) \neq \emptyset$
c.	$A_{i,t} \xrightarrow{p} A_j \Rightarrow t_i^i \wedge \bigwedge_{s \in \text{SAFE}(A_{i,t} \xrightarrow{p} A_j)} s @ A_j$
until no further replacements are possible (i.e., the assessment expression consists only of literals with no causal support and terms of the form ρ_i^i).	
3. Convert the assessment expression to disjunctive normal form.	
4. Using the probabilistic axiom $P[A \vee B] = P[A] + P[B] - P[A \wedge B]$, compute the set of disjuncts of the DNF expression that must be conjoined to compute the probability of the expression as a whole.	
5. Compute the probability of each conjunction as follows:	
If the conjunction contains terms of the form ρ_i^i and ρ_k^i , or $p @ A_i$ and $\bar{p} @ A_i$, then	
a. the probability of the expression is 0	
otherwise	
b. remove duplicate terms, substitute probabilities for the remaining terms (the value of each ρ_i^i , and 0 for each remaining $p @ A_i$), and	
c. multiply the results	
6. Add or subtract (as appropriate) the probabilities as computed by line 5 for each of the conjunctions generated by line 4.	
PROD($p @ A_i$)	
returns the set of \mathcal{P} 's unthreatened causal links supporting $p @ A_i$.	
SAFE($A_{i,t} \xrightarrow{p} A_j$)	
returns the set of safety propositions corresponding to confronted threats against $A_{i,t} \xrightarrow{p} A_j$ in \mathcal{P} .	

Table 7: REVERSE plan assessment algorithm.

We have not fully investigated the computational complexity of REVERSE, but clearly the algorithm runs in time exponential in the number of disjuncts in the disjunctive normal form of the assessment expression: Line 5 computes the probability of each conjunction generated by Line 4, and the number of such conjunctions is exponential in the number of disjuncts.

Example: We now show how REVERSE assesses the plan shown in Figure 7. From Line 1 of Table 7, the initial assessment expression is simply t_α^G . This gets transformed by several applications of Lines 2.a and 2.b as follows:

$$\begin{aligned}
 t_\alpha^G &\Rightarrow \rho_\alpha^G \wedge \text{HB} @ A_G \wedge \text{BP} @ A_G \wedge \text{GC} @ A_G \\
 &\Rightarrow \rho_\alpha^G \wedge A_{1,\alpha} \xrightarrow{\text{HB}} A_G \wedge A_{2,\beta} \xrightarrow{\text{BP}} A_G \wedge A_{0,\alpha} \xrightarrow{\text{GC}} A_G
 \end{aligned}$$

Each of these links is then expanded using Line 2.c. Expanding $A_{1,\alpha} \xrightarrow{\text{HB}} A_G$ and $A_{2,\beta} \xrightarrow{\text{BP}} A_G$ is straightforward: these links just expand into their producing outcomes. But $A_{0,\alpha} \xrightarrow{\text{GC}} A_G$ was threatened by paint (A_2) and this threat was resolved by confrontation. So in addition to the producing outcome, $A_{0,\alpha} \xrightarrow{\text{GC}} A_G$ expands into the safety proposition subgoal $s_1 \otimes A_G$, and we have:

$$\rho_\alpha^G \wedge A_{1,\alpha} \xrightarrow{\text{HB}} A_G \wedge A_{2,\beta} \xrightarrow{\text{BP}} A_G \wedge A_{0,\alpha} \xrightarrow{\text{GC}} A_G \Rightarrow \rho_\alpha^G \wedge t_\alpha^1 \wedge t_\beta^2 \wedge (t_\alpha^0 \wedge s_1 \otimes A_G)$$

Now applying Lines 2.a, 2.b and 2.c, we have:

$$\begin{aligned} \rho_\alpha^G \wedge t_\alpha^1 \wedge t_\beta^2 \wedge t_\alpha^0 \wedge s_1 \otimes A_G &\Rightarrow \rho_\alpha^G \wedge (\text{GD} \otimes A_1 \wedge \rho_\alpha^1) \wedge (\overline{\text{HB}} \otimes A_2 \wedge \rho_\beta^2) \wedge \rho_\alpha^0 \wedge A_{2,\beta} \xrightarrow{s_1} A_G \\ &\Rightarrow \rho_\alpha^G \wedge (A_{0,\alpha} \xrightarrow{\text{GD}} A_1 \wedge \rho_\alpha^1) \wedge (A_{1,\alpha} \xrightarrow{\text{HB}} A_2 \wedge \rho_\beta^2) \wedge \rho_\alpha^0 \wedge t_\beta^2 \\ &\Rightarrow \rho_\alpha^G \wedge (t_\alpha^0 \wedge \rho_\alpha^1) \wedge (t_\alpha^0 \wedge \rho_\beta^2) \wedge \rho_\alpha^0 \wedge (\overline{\text{HB}} \otimes A_2 \wedge \rho_\beta^2) \\ &\Rightarrow \rho_\alpha^G \wedge (\rho_\alpha^0 \wedge \rho_\alpha^1) \wedge (\rho_\alpha^0 \wedge \rho_\beta^2) \wedge \rho_\alpha^0 \wedge (A_{1,\alpha} \xrightarrow{\text{HB}} A_2 \wedge \rho_\beta^2) \\ &\Rightarrow \rho_\alpha^G \wedge \rho_\alpha^0 \wedge \rho_\alpha^1 \wedge \rho_\alpha^0 \wedge \rho_\beta^2 \wedge \rho_\alpha^0 \wedge (t_\alpha^0 \wedge \rho_\beta^2) \\ &\Rightarrow \rho_\alpha^G \wedge \rho_\alpha^0 \wedge \rho_\alpha^1 \wedge \rho_\alpha^0 \wedge \rho_\beta^2 \wedge \rho_\alpha^0 \wedge \rho_\alpha^0 \wedge \rho_\beta^2 \end{aligned}$$

As this point, the termination condition of Line 2 is satisfied, so Line 3 transforms the expression into disjunctive normal form. Since it is already just a conjunction, no transformation is needed. For the same reason, Line 4 is trivial: we use Line 5 to assess the probability of the entire expression.

The expression contains no contradictions, so Line 5.a does not apply. Rather, Line 5.b first removes duplicates, substitutes numbers for the remaining terms, and multiplies:

$$\begin{aligned} \rho_\alpha^G \wedge \rho_\alpha^0 \wedge \rho_\alpha^1 \wedge \rho_\alpha^0 \wedge \rho_\beta^2 \wedge \rho_\alpha^0 \wedge \rho_\alpha^0 \wedge \rho_\beta^2 &\Rightarrow \rho_\alpha^G \wedge \rho_\alpha^0 \wedge \rho_\alpha^1 \wedge \rho_\beta^2 \\ &\Rightarrow 1.0 \times 0.7 \times 0.95 \times 0.9 \\ &\Rightarrow 0.5985. \end{aligned}$$

This example illustrates that the probability computed by REVERSE is a lower bound on the exact probability that a plan achieves the goal: the other algorithms return 0.7335 when they assess this plan. In order for REVERSE to realize this exact probability, additional causal links would need to be added to the plan. For example, the link $A_{0,\beta} \xrightarrow{\text{GC}} A_G$ represents a way that the goal GC might be achieved that REVERSE has not considered.

References

- [1] J. Allen, J. Hendler, and A. Tate, editors. *Readings in Planning*. Morgan Kaufmann, San Mateo, CA, August 1990.
- [2] J. Ambros-Ingerson and S. Steel. Integrating planning, execution, and monitoring. In *Proc. 7th Nat. Conf. on A.I.*, pages 735–740, 1988.
- [3] J. Breese, R. Goldman, and M. Wellman, editors. *Notes from the Ninth National Conference on Artificial Intelligence (AAAI-91) Workshop on Knowledge-Based Construction of Probabilistic and Decision Models*. AAAI, July 1991.
- [4] R. Brost. Automatic grasp planning in the presence of uncertainty. *International Journal of Robotics Research*, 7(1):3–17, February 1988.
- [5] D. Chapman. Planning for conjunctive goals. *Artificial Intelligence*, 32(3):333–377, 1987.
- [6] L. Chrisman. Abstract Probabilistic Modeling of Action. In *Proc. 1st Int. Conf. on A.I. Planning Systems*, 1992.
- [7] G. Collins and L. Pryor. Achieving the functionality of filter conditions in a partial order planner. In *Proc. 10th Nat. Conf. on A.I.*, August 1992.
- [8] G. Cooper. The computational complexity of probabilistic inference using bayesian belief networks. *Artificial Intelligence*, 42, 1990.
- [9] P. Dagum and M. Luby. Approximating Probabilistic Inference in Bayesian Networks is NP-Hard. *Artificial Intelligence*, 60(1):141–153, March 1993.
- [10] T. Dean and M. Boddy. Reasoning about partially ordered events. *Artificial Intelligence*, 36(3):375–400, October 1988. Reprinted in [56].
- [11] T. Dean and M. Wellman. *Planning and Control*. Morgan Kaufmann, 1991.
- [12] Thomas Dean, Leslie Kaelbling, Jak Kirman, and Ann Nicholson. Planning with deadlines in stochastic domains. In *Proc. 11th Nat. Conf. on A.I.*, July 1993.
- [13] Thomas Dean and Keiji Kanazawa. A model for reasoning about persistence and causation. *Computational Intelligence*, 5:142–150, 1989.
- [14] B. Donald. A geometric approach to error detection and recovery for robot motion planning with uncertainty. *Artificial Intelligence*, 37:223–271, 1988 1988.
- [15] D. Draper, S. Hanks, and D. Weld. A probabilistic model of action for least-commitment planning with information gathering. In *Proc., Uncertainty in AI*, 1994. Submitted.

- [16] D. Draper, S. Hanks, and D. Weld. Probabilistic planning with information gathering and contingent execution. In *Proc. 2nd Int. Conf. on A.I. Planning Systems*, June 1994.
- [17] M. Drummond and J. Bresina. Anytime Synthetic Projection: Maximizing the Probability of Goal Satisfaction. In *Proc. 8th Nat. Conf. on A.I.*, 1990.
- [18] M. Erdmann. On Motion Planning with Uncertainty. AI-TR-810, MIT AI LAB, August 1984.
- [19] K. Erol, D. Nau, and V. Subrahmanian. When is planning decidable? In *Proc. 1st Int. Conf. on A.I. Planning Systems*, pages 222–227, June 1992.
- [20] O. Etzioni, S. Hanks, D. Weld, D. Draper, N. Lesh, and M. Williamson. An Approach to Planning with Incomplete Information. In *Proc. 3rd Int. Conf. on Principles of Knowledge Representation and Reasoning*, October 1992. Available via FTP from pub/ai/ at cs.washington.edu.
- [21] A. Farley. A Probabilistic Model for Uncertain Problem Solving. *IEEE Transactions on Systems, Man, and Cybernetics*, 13(4), July 1983.
- [22] J. Feldman and R. Sproull. Decision theory and artificial intelligence II: The hungry monkey. *Cognitive Science*, 1:158–192, 1977.
- [23] R. Fikes and N. Nilsson. STRIPS: A new approach to the application of theorem proving to problem solving. *Artificial Intelligence*, 2(3/4), 1971.
- [24] Robert P. Goldman and Mark S. Boddy. Epsilon-safe planning. forthcoming, 1994.
- [25] Robert P. Goldman and John S. Breese. Integrating Model Construction and Evaluation. In *Proc. 8th Conf. on Uncertainty in Artificial Intelligence*, July 1992.
- [26] Peter Haddawy and Steve Hanks. Utility Models for Goal-Directed Decision-Theoretic Planners. Technical Report 93–06–04, Univ. of Washington, Dept. of Computer Science and Engineering, September 1993. Submitted to *Artificial Intelligence*. Available via FTP from pub/ai/ at cs.washington.edu.
- [27] K. Hammond. Explaining and repairing plans that fail. *Artificial Intelligence*, 45:173–228, 1990.
- [28] S. Hanks. Practical temporal projection. In *Proc. 8th Nat. Conf. on A.I.*, pages 158–163, August 1990.
- [29] S. Hanks. *Projecting Plans about Uncertain Worlds*. PhD thesis, Yale University Computer Science Department, January 1990.
- [30] Steve Hanks. Modeling a Dynamic and Uncertain World II: Action Representation and Plan Evaluation. Technical report, Univ. of Washington, Dept. of Computer Science and Engineering, September 1993.

- [31] Steve Hanks and Drew McDermott. Modeling a Dynamic and Uncertain World I: Symbolic and Probabilistic Reasoning about Change. *Artificial Intelligence*, 65(2), 1994.
- [32] R. Howard and J. Matheson. Influence Diagrams. In *The Principles and Applications of Decision Analysis*. Strategic Decisions Group, 1984.
- [33] S. Kambhampati. Characterizing multi-contributor causal structures for planning. In *Proc. 1st Int. Conf. on A.I. Planning Systems*, pages 116–125, June 1992.
- [34] S. Koenig. Optimal probabilistic and decision-theoretic planning using markovian decision theory. UCB/CSD 92/685, Berkeley, May 1992.
- [35] K. Krebsbach, D. Olawsky, and M. Gini. An empirical study of sensing and defaulting in planning. In *Proc. 1st Int. Conf. on A.I. Planning Systems*, pages 136–144, June 1992.
- [36] T. Lozano-Perez, M. Mason, and R. Taylor. Automatic synthesis of fine motion strategies for robots. *International Journal of Robotics Research*, 3(1):3–24, Spring 1984.
- [37] T. Mansell. A method for planning given uncertain and incomplete information. In *Proc. 9th Conf. on Uncertainty in Artificial Intelligence*, 1993.
- [38] N. Martin and J. Allen. A Language for Planning with Statistics. In *Proc. 7th Conf. on Uncertainty in Artificial Intelligence*, 1991.
- [39] D. McAllester and D. Rosenblitt. Systematic nonlinear planning. In *Proc. 9th Nat. Conf. on A.I.*, pages 634–639, July 1991.
- [40] D. McDermott. Regression planning. *International Journal of Intelligent Systems*, 6:357–416, 1991.
- [41] R. Moore. A Formal Theory of Knowledge and Action. In J. Hobbs and R. Moore, editors, *Formal Theories of the Commonsense World*. Ablex, Norwood, NJ, 1985.
- [42] John H. Munson. Robot Planning, Execution, and Monitoring in an Uncertain Environment. In *Proc. 2nd Int. Joint Conf. on A.I.*, pages 338–349, August 1971.
- [43] D. Olawsky and M. Gini. Deferred planning and sensor use. In *Proceedings, DARPA Workshop on Innovative Approaches to Planning, Scheduling, and Control*. Morgan Kaufmann, 1990.
- [44] J. Pearl. *Probabilistic Reasoning in Intelligent Systems*. Morgan Kaufmann, San Mateo, CA, 1988.
- [45] E. Pednault. *Toward a Mathematical Theory of Plan Synthesis*. PhD thesis, Stanford University, December 1986.

- [46] E. Pednault. Synthesizing plans that contain actions with context-dependent effects. *Computational Intelligence*, 4(4):356–372, 1988.
- [47] E.. Pednault. Generalizing nonlinear planning to handle complex goals and actions with context-dependent effects. In *Proc. 12th Int. Joint Conf. on A.I.*, July 1991.
- [48] J. S. Penberthy and Daniel S. Weld. A new approach to temporal planning (preliminary report). In *Proceedings of the AAAI 1993 Symposium on Foundations of Automatic Planning: The Classical Approach and Beyond*, pages 112–116, March 1993.
- [49] J.S. Penberthy. *Planning with Continuous Change*. PhD thesis, University of Washington, 1993. Available as UW CSE Tech Report 93-12-01.
- [50] J.S. Penberthy and D. Weld. UCPOP: A sound, complete, partial order planner for ADL. In *Proc. 3rd Int. Conf. on Principles of Knowledge Representation and Reasoning*, pages 103–114, October 1992. Available via FTP from pub/ai/ at cs.washington.edu.
- [51] M. Peot and John S. Breese. Model Construction in Planning. In *Notes from the Ninth National Conference on Artificial Intelligence (AAAI-91) Workshop on Knowledge-Based Construction of Probabilistic and Decision Models*, pages 95–100, July 1991.
- [52] M. Peot and D. Smith. Conditional Nonlinear Planning. In *Proc. 1st Int. Conf. on A.I. Planning Systems*, pages 189–197, June 1992.
- [53] J. Robinson. A machine-oriented logic based on the resolution principle. *Journal of the ACM*, 12(1), January 1965.
- [54] R. Simmons. A theory of debugging plans and interpretations. In *Proc. 7th Nat. Conf. on A.I.*, pages 94–99, August 1988.
- [55] Sampath Srinivas and Jack Breese. IDEAL: Influence diagram evaluation and analysis in lisp; documentation and users guide. Technical Memo 23, Rockwell International Science Center, August 1990.
- [56] D. Weld and J. de Kleer, editors. *Readings in Qualitative Reasoning about Physical Systems*. Morgan Kaufmann, San Mateo, CA, August 1989.
- [57] M. Wellman and J. Doyle. Modular utility representation for decision theoretic planning. In *Proc. 1st Int. Conf. on A.I. Planning Systems*, pages 236–242, June 1992.



Creation date: 09-22-2003
Indexing Officer: AMOHAMMED - AMIR N. MOHAMED
Team: OIPEScanning
Dossier: 10659020

Legal Date: 09-11-2003

No.	Doccode	Number of pages
1	FOR	24
2	FOR	10
3	FOR	110

Total number of pages: 144

Remarks:

Order of re-scan issued on

10.659.020

9-11-03



A DOCPHOENIX

☐ TRNA _____
Transmittal New Application

☐ SPEC _____
Specification

☐ CLM _____
Claims

☐ ABST _____
Abstract

☐ DRW _____
Drawings

☐ OATH _____
Oath or Declaration

☐ ADS _____
Application Data Sheet

☐ A... _____
Amendment Including Elections

☐ A.PE _____
Preliminary Amendment

☐ REM _____
Applicant Remarks in Amendment

☐ IDS _____
IDS Including 1449

☐ 371P _____
PCT Papers in a 371P Application

☒ FOR 24 _____
Foreign Reference

☐ NPL _____
Non-Patent Literature

☐ FRPR _____
Foreign Priority Papers

☐ ARTIFACT _____
Artifact

☐ LET. _____
Misc. Incoming Letter

☐ IMIS _____
Misc. Internal Document

☐ TRREISS _____
Transmittal New Reissue Application

☐ PROTRANS _____
Translation of Provisional in Nonprovisional

☐ BIB _____
Bib Data Sheet

☐ WCLM _____
Claim Worksheet

☐ WFEE _____
Fee Worksheet

☐ APPENDIX _____
Appendix

☐ COMPUTER _____
Computer Program Listing

☐ SPEC NO _____
Specification Not in English

☐ N417 _____
Copy of EFS Receipt Acknowledgement

☐ CRFL _____
Computer Readable Form Transfer Request Filed

☐ CRFS _____
Computer Readable Form Statement

☐ SEQLIST _____
Sequence Listing

☐ SIR. _____
SIR Request

☐ AF/D _____
Affidavit or Exhibit Received

☐ DIST _____
Terminal Disclaimer Filed

☐ PET. _____
Petition

☐ END JOB☒ DUPLEX

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



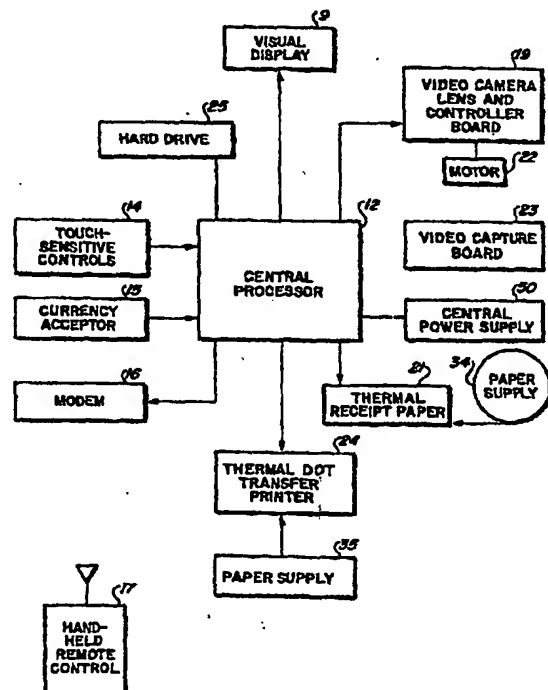
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6: G03B 29/00	A1	(11) International Publication Number: WO 97/04353
		(43) International Publication Date: 6 February 1997 (06.02.97)
(21) International Application Number: PCT/US95/11877		(81) Designated States: BR, JP, MX, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published With international search report.
(22) International Filing Date: 18 September 1995 (18.09.95)		
(30) Priority Data: 08/502,483 14 July 1995 (14.07.95) US		
(71)(72) Applicant and Inventor: CHUMBLEY, Gregory, R. [US/US]; Suite 902, 2999 Concorde Centre Drive, Miami, FL 33180 (US).		
(74) Agent: DOWNEY, Robert, M.; Robert M. Downey, P.A., Suite 1480, 701 Brickell Avenue, Miami, FL 33131 (US).		

(54) Title: **POSTAGE AND PHOTO VENDING APPARATUS**

(57) Abstract

An apparatus for producing and printing a photograph includes touch-sensitive controls, a visual display, a currency receiving and/or dispensing device, a hand-held remote control device for adjusting location of a photo image area on the visual display and controlling capture of a photo image of the user from a video camera lens and controller board, a first printer and a second printer, all connected to a central processor. Video impressions viewed by the camera lens are converted into a series of electrical impulses, which are selectively captured and digitized. Thereafter, a digitized photo image of the user is either combined with a stored postage meter image for printing by the second printer to produce a printed photograph on one side of an adhesive-backed postage meter strip, or, alternatively, uploaded by a high-speed modem to a host computer for processing a passport, driver's license, or other government identification-type document requiring a photograph.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/11877**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : G03B 29/00

US CL : 354/76

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 354/75,76,109,111,266

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,024,380 (Gunn) 17 May 1977, see entire document	14,15,18,21,22
A	US, A, 5,184,160 (Massarsky) 02 February 1993	8-9
Y	US, A, 5,204,753 (Tai) 20 April 1993, col. 2, lines 55-60	16-17
Y	US, A, 5,202,765 (Lineberry) 13 April 1993, col. 1, lines 10-25	5-7
Y	US, A, 5,343,386 (Barber) 30 August 1994, see entire document	1-23
Y	US, A, 5,389,986 (Tsuji et al.) 14 February 1995, see entire document	3,7,9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	-T- later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

30 NOVEMBER 1995

Date of mailing of the international search report

04 MAR 1996

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

Chapik

Telephone No. (703) 308-7620

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/11877

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,453,926 (Stroschin et al.) 26 September, 1995, col.1 lines 54-60	2

Form PCT/ISA/210 (continuation of second sheet)(July 1992)*

POSTAGE AND PHOTO VENDING APPARATUS

BACKGROUND OF THE INVENTIONField of the Invention

This invention relates generally to a photography apparatus for producing printed pictures, and more specifically to an apparatus adapted to generate a digitized photo image to be either combined with a postage meter image and/or related postal indicia for printing on an adhesive-backed postage meter strip, or to be uploaded to a host computer.

Description of the Related Art

Postage stamps bearing the portrait of a famous person or historical site have long been an item of interest, especially to stamp collecting enthusiasts. The release by Federal Post Offices of stamps bearing the portraits of famous celebrities has heightened the general public's interest and demand for "special issue" stamps. In view of the public's infatuation with these novelty stamps, it is believed that many postage purchasers would find it exciting to have their personal photo on a stamp. However, the Federal Postal Regulations of most countries prohibit the application of a personal photograph, or other personal artistic expressions, to a stamp. On the other hand, it may be permissible to apply such a personal photo to a postage meter strip, wherein a printing device applies certain images representing a value of postage to a strip of adhesive-backed paper or other suitable photographic medium.

In light of this, there is a need for a device having the ability to combine a personalized photograph with a value of postage (pre-determined or otherwise) on an adhesive-backed postage meter strip for subsequent application to an envelope, postcard, or other item of mail.

In the field relating to photograph vending apparatus, it is known to provide a self-service photo booth or

apparatus for taking one's portrait without the services of a photographer. Apparatus of this type are generally operable by depositing money through a currency receiving mechanism, prompting a camera to take one or more photographs of an individual. The photographs are thereafter developed by wet chemicals within the apparatus and then dispensed to the purchaser after several minutes. In some instances, backgrounds are provided to create a personalized photo, which can be used as a postcard. This has been accomplished by use of various methods, including the use of fixed or interchangeable backdrops behind the persons being photographed.

More recently, self-service photo machines have been equipped with computers, enabling a user to quickly select a backdrop scene from a collection of computer-stored backgrounds. An example of this type of apparatus is disclosed in U.S. Patent No. 5,343,386 to Barber. In this particular apparatus, a self portrait of the user is integrated with the selected background scene, wherein the combined photo is thereafter color printed on a postcard having pre-printed areas on an opposite side for application of postage, address, and a message.

Self-service photo machines may also be useful for obtaining paper passport photos. However, in an attempt to curb fraudulent misuses of its passports, such as switching passport photographs with that of someone other than the true passport holder, Federal Passport Agencies are currently developing systems whereby passport photographs will be scanned by a digital camera or flatbed scanner means and combined with the holder's name, address, date of birth, and all other pertinent information as required on passports. The resultant digitized photograph, combined with the pertinent information of the holder, will be printed on an adhesive-backed clear plastic film, similar in appearance to an overhead projection cell. This film can then be adhered to the inside of a passport and forwarded to the proper passport applicant. A similar process may be

used to issue new driver's licenses and other permits and licenses requiring a photograph for identification.

In light of the fact that Federal Passport Agencies may no longer utilize paper photographs for adherence to its issued passports, but instead utilize digital photo image files, there is a need for a device that produces digital photo image files in such places as post offices, courthouses, etc. In this manner, the digital photo image files can be uploaded to the Passport Agency's central computer by high-speed modem in lieu of scanning a paper photograph in order to create the digitized photograph.

In spite of the various applications and uses for which self-service photo machines have been adapted, none have combined the purchase of a personalized photograph with the purchase of postage. More specifically, there has not been developed an apparatus that integrates a personalized photograph with an adhesive-backed postage meter strip representing a value of postage (pre-determined or otherwise), for subsequent application to an item of mailing. Furthermore, the photograph machines in the related art fail to provide a means to store a digitized photo image for subsequent uploading to a Federal Passport Agency computer for use in processing a passport application.

Accordingly, the present invention provides for the novel combination of a personal photograph integrated with a value of postage and printed on an adhesive-backed postage meter strip, as well as the uploading of a digitized photo image to a host computer.

Summary of the Invention

The present invention is directed to an apparatus for producing a photograph integrated with a postage meter image displaying a particular value of postage on an adhesive-backed postage meter strip. In accordance with the apparatus of the present invention, there is provided touch-sensitive controls, a visual display means, a currency

receiving and/or dispensing device, a hand-held remote control device, a central processor, a hard drive, a high-speed modem, a video camera lens with a controller board positioned and disposed to view and receive a video impression of the user, a thermal receipt printer, and a thermal dot transfer printer or other suitable printer means.

The apparatus is primarily intended for installation in commercial areas such as post offices, courthouses, supermarkets, transportation facilities, etc. as a convenient means for consumers to purchase personalized postage meter strips.

It is a further object of the invention to provide a means for creating passport photo image files. Thus, the present invention eliminates the need to search for a passport photographer, make an appointment, and then travel to the location for the passport photo session.

The photo image files are uploaded by the device to Federal Passport Processing Centers or to a site on the Internet by high-speed modem communications and can be imported directly into the Agency's passport processing software without the necessity of subsequent scanning by the Agency. No device has been developed that provides a self-service means whereby, for a nominal charge, consumers can capture a digital photo image of themselves that is suitable for use by a Federal Passport Agency in issuing to them a valid passport.

In operation, the user simply approaches the apparatus, where he or she is prompted with easy-to-follow instructions appearing on a visual display means. After selecting "Passport Photo" or "PhotoStamp" by touching touch-sensitive controls, the user deposits the indicated amount of money through the currency receiving and/or dispensing device.

If the user selects "Passport Photo," he or she is then instructed on how to use the remote control device for adjusting the camera lens and capturing the photo image when ready. The user is further instructed to stand directly on top of a pair of shoe silhouettes that are affixed to the

floor approximately 6 feet from the camera lens and capture (or freeze) the image that appears in the visual display at will. Depending on the surroundings of a particular location, a white-colored backdrop may be provided, positioned directly behind the shoe silhouettes.

Within approximately 10-30 seconds after the passport photo image has been captured by the user, duplicate receipts are dispensed by the thermal receipt printer; one copy is retained by the user, the other is given to a passport agent by the user, who in turn attaches the receipt to the passport application in lieu of the customary two-inch by two-inch paper passport photo. The thermal paper receipt bears the applicant's photo, at 100 to 300 dpi of resolution. The receipt also displays a Passport Agency File Number in Bar Code form, a date/time stamp, location number, and any other pertinent information as may be required by a Federal Passport Agency.

At pre-determined intervals, the device logs onto a host computer via high-speed modem and uploads the passport photo image files created since the last upload to a Federal Passport Processing Center or Centers, or to a designated site on the Internet. Once uploaded, the files are stored until retrieved by a Federal Passport Processing Center.

A particular photo image file is retrieved by its file name, i.e., the Federal Passport Agency file number appearing on the applicant's receipt, which may be read into the host computer by a bar code reader device. After the passport photo image file has been created and receipts issued to the user, the display means may solicit the user to purchase a "PhotoStamp."

If the user purchases a passport photo image and then decides to purchase a "PhotoStamp," the "PhotoStamp" may be created with the same photo image that was created for the passport. Alternatively, the user can elect to capture a new photo image for use on the "PhotoStamp" if he or she so desires. The user simply deposits an additional sum of money through the currency receiving and/or dispensing

device and follows the instructions appearing on the visual display. If no new photo image is to be taken, the thermal dot transfer printer or other suitable printer means will dispense the "PhotoStamp," or a plurality thereof, within 30 to 60 seconds.

If the user elects to capture a new photo image for the "PhotoStamp," the user is instructed to stand directly on top of a pair of shoe silhouettes that are affixed to the floor approximately 6 feet from the camera lens. The camera is activated and the user can capture (or freeze) the image that appears in the visual display at will, using the remote control device.

With the foregoing in mind, it is a primary object of the present invention to provide an apparatus for producing a personalized photograph integrated with a postage meter image displaying a value of postage on an adhesive-backed postage meter strip for subsequent application to an envelope, postcard, or other item of mail.

It is a further object of the present invention to provide an apparatus, as set forth above, adapted to produce passport photo image files for uploading to a Federal Passport Processing Center or Centers, or its site on the Internet, via high-speed modem communications.

It is still a further object of the present invention to provide a convenient means for purchasing a "PhotoStamp," comprised of an adhesive-backed postage meter strip bearing a personalized photograph of the consumer, with the added option of purchasing and capturing a passport photo image file to be later utilized by a Federal Passport Processing Center in lieu of a standard paper photograph.

It is still a further object of the present invention to provide a self-service photograph apparatus which can be conveniently installed in commercial areas, such as post offices, courthouses, etc., eliminating the need to engage the services of passport photographers.

It is yet a further object of the present invention to provide an apparatus, as set forth above, which is adapted

for use by governmental agencies that issue permits and licenses whereby a photograph of the applicant is needed, including, but not limited to, driver's licenses.

These and other objects and advantages will be more readily apparent in the description which follows.

Brief Description of the Drawings

For a fuller understanding of the nature of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

Figure 1 is a block diagram of the functional component elements of the apparatus of the present invention;

Figure 2 is a front view of the apparatus, showing the front face thereof;

Figure 3 is a side view illustrating a preferred installation setup of the apparatus;

Figure 4A is a side elevation of a backdrop used in connection with the apparatus;

Figure 4B is a top plan view of the backdrop of Figure 4A;

Figure 5 is a top plan view of an example "PhotoStamp" produced by the apparatus shown attached to an envelope;

Figure 6 is a top plan view of an alternative form of an example "PhotoStamp" produced by the apparatus; and

Figure 7 is a top plan view of an example passport photo image receipt produced by the thermal receipt printer.

Like reference numerals refer to like parts throughout the several views of the drawings.

Detailed Description of the Preferred Embodiment

Referring initially to Figure 1, there is illustrated, in block diagram form, the component elements of the photo and postage apparatus 10, with the controlling interaction between the various components being indicated by the interconnecting arrows. In accordance with a preferred

embodiment of the present invention, the apparatus 10 includes a central processor 12 which is programmed with a series of instructions that define operating sequences in response to signals received from touch-sensitive controls 14, a visual display means 9, a hard drive 25, high-speed modem 16, a currency receiving and/or dispensing device 15, a hand-held remote control device 17, a video camera lens with a controller board 19, a video capture board 23, a thermal receipt printer 21, and a thermal dot transfer printer or other suitable printer means 24. Most of the various components of the apparatus 10 are powered by a central power supply 50.

The program in the central processor further provides operating instructions which are transmitted to the visual display 9, prompting a user to deposit a predetermined amount of money to operate the apparatus and to further enter various operating commands on the touch-sensitive controls 14. Initiation of the primary operating sequences is triggered by depositing at least a specified amount of money through the currency receiving and/or dispensing device 15. A hard drive 25 is provided for storing the passport photo image files for uploading via the high-speed modem 16. A memory source is provided on the central processor 12 for storing the postage meter image and/or other postal indicia 40 of the type similarly printed on current postage meter strips and representing a value of postage paid.

A video viewing means includes a video camera lens and controller board 19 structured and disposed for viewing and receiving a video impression and for converting the received impression into a series of electrical impulses. The video camera lens and controller board 19 is generally of the type found in a common hand-held video camcorder or video camera, and is interconnected to and activated by the central processor 12. A motor 22, controlled by the central processor 12, adjusts the angle of the video camera lens relative to the subject being photographed so that the

subject's head is correctly centered vertically within a defined image area on the visual display 9. The central processor 12 operates motor 22 in response to command signals received by the hand-held remote device 17. The electrical impulses representing the viewed and received video impression are delivered from the controller board 19 to a video capture board 23, where the electrical impulses are digitized and stored for subsequent transfer to the central processor 12. The timing of the transfer of the digitized signals (representing at least a single frame of video) is determined by the program in the central processor 12 in accordance with the defined operating sequence.

The captured digitized signals, representing the received video impression, are thereafter integrated with the stored postage meter image and/or other postal indicia in the memory source on the central processor 12. Thereafter, the integrated image (video impression and postage meter image) is transferred from the central processor 12 to a thermal dot transfer printer or other suitable printer means 24, which is activated in sequence in response to a series of instructions by the program in the central processor 12. The combined images are delivered to the thermal dot transfer printer or other suitable printer means 24 in the form of electronic impulse signals. The impulse signals are converted into a photograph, representing the viewed video impression and the postage meter image, and printed on an adhesive-backed postage meter strip 40. One or more postage meter strips 40 are dispensed from a paper supply 35 for individual delivery to the thermal dot transfer printer or other suitable printer 24 upon demand. After printing, the postage meter strip (or a plurality thereof) 40 is dispensed and delivered to the user bearing the user's photograph (see Figures 5 and 6).

The program in the central processor further provides for the production of properly sized passport photo image files, wherein the postage meter indicia images are not integrated with the photo image file. In this particular

instance, the captured electrical impulses, representing the viewed video impression, are transferred from the central processor 12 to the hard drive 25 without integration with the postage meter images, so that only a passport photo image file is produced and stored on the hard drive 25. The stored passport photo image file is subsequently uploaded to a host computer, such as a site on the Internet or a government agency, via the high-speed modem 16.

Referring to Figures 2 and 3, the apparatus 10 is shown mounted within an upright enclosure in accordance with what may be a preferred commercial installation. In operation, the user would approach the exposed face of the apparatus 10 where he or she is prompted with easy-to-follow instructions appearing on a visual display means 9. After depositing the required amount of money through the currency acceptor and/or dispensing device 15 and making appropriate entries by touching touch-sensitive controls 14, the user is instructed to place his/her feet directly on top of a pair of shoe silhouettes 66, which are affixed to the floor approximately 6 feet from the camera lens 19 (See Figure 3). A white colored backdrop 70, or other background scene, may be positioned directly behind the shoe silhouettes 66, depending on the surroundings of a particular location.

Each apparatus can be individually programmed to provide specific identifying postal indicia on the "PhotoStamp." By connecting to the apparatus with a modem 16, a special security code number specific to a particular apparatus 10 is entered to enable programming of specific data. In particular, the user, such as the post office, can enter the city, state, zip code, current date, and any other pertinent data into the central processor 12. This information is stored on the hard disk. The entered data is used to produce a completed "PhotoStamp." The date (and time, if applicable) which is printed on the "PhotoStamp" is maintained by the central processor's built-in clock. The apparatus 10 further has the capability of generating reports. In particular, a report of the day's activity

(e.g., number of "PhotoStamps" and/or passport photo image files created), plus a running total of the money received, is output on demand via the thermal receipt printer 21, or uploaded via modem 16.

While the invention has been shown and described in what is considered to be a practical and preferred embodiment, it is recognized that departures may be made within the spirit and scope of the following claims which, therefore, should not be limited except within the Doctrine of Equivalents.

Now that the invention has been described,

Claims

1. An apparatus for producing photographs comprising:
input means for entering operational selections to generate control signals,

a central processor programmed with a series of instructions that define operating sequences responsive to received signals including said control signals,

video viewing means including a video camera lens and a controller board structured and disposed for viewing and receiving a video impression and being further structured to convert said received video impression into a series of electrical impulses,

video capture means connected to said central processor and said video viewing means for selectively receiving and digitizing a select group of said series of electrical impulses to create a digitized photo image for subsequent transfer to said central processor, and

printer means connected to said central processor and activated in sequence in response to said series of instructions, and being structured and disposed to receive electronic impulse signals from said central processor and to print on a substrate.

2. An apparatus as recited in claim 1 wherein said input means includes a visual display means including a surface having sensitivity means responsive to touch to generate said control signals.

3. An apparatus as recited in claim 2 wherein said input means further includes a hand-held remote control means.

4. An apparatus as recited in claim 3 wherein said visual display means is structured and disposed to receive said series of electrical impulses and to further display said viewed video impression.

5. An apparatus as recited in claim 4 wherein said viewed video impression is displayed on said visual display means within a defined photo image area on said visual display means.

6. An apparatus as recited in claim 5 further including means for adjusting and controlling the location of said photo image area on said visual display means.

7. An apparatus as recited in claim 6 wherein said means for adjusting and controlling location of said photo image area on said visual display means is responsive to signals from said hand-held remote control.

8. An apparatus as recited in claim 7 further including means for selectively adjusting the position of said video camera lens through a range of adjusted positions.

9. An apparatus as recited in claim 8 wherein said means for selectively adjusting the position of said video camera lens is operable in response to said signals from said hand-held remote control.

10. An apparatus as recited in claim 1 further including means for storing said digitized photo image.

11. An apparatus as recited in claim 10 further including means for uploading said digitized photo image to a host computer.

12. An apparatus for producing photographic image files comprising:

input means for entering operational selections to generate control signals,

a central processor programmed with a series of instructions that define operating sequences responsive to received signals including said control signals,

camera means for viewing an image and converting the viewed image into a series of electrical impulses,

means for capturing at least a portion of said series of electrical impulses,

means for digitizing said captured series of electrical impulses to create a digitized photo image,

means for storing said digitized photo image, and

means for uploading said stored digitized photo image to a host computer.

13. An apparatus as recited in claim 12 wherein said

means for uploading includes modem means.

14. An apparatus for producing photographic image files comprising:

input means for entering operational selections to generate control signals,

a central processor programmed with a series of instructions that define operating sequences responsive to received signals including said control signals, and including a data storage means for storing at least one postage meter image representing a value of postage,

video viewing means including a video camera lens and a controller board structured and disposed for viewing and receiving a video impression and being further structured to convert said received video impression into a series of electrical impulses,

means for capturing at least a portion of said series of electrical impulses,

means for digitizing said captured series of electrical impulses to create a digitized photo image,

means for storing said digitized photo image,

means for selectively uploading said stored digitized photo image to a host computer,

means for selectively combining said stored digitized photo image with said stored postage meter image, and

printer means connected to said central processor and activated in sequence in response to said series of instructions, and being structured and disposed to receive electronic impulse signals, including electronic impulse signals comprised of the combination of said digitized photo image and said postage meter image, and to print indicia including a visual production of the digitized photo image combined with the postage meter image on a substrate.

15. An apparatus as recited in claim 14 wherein said printer means includes a first printer for printing receipts and a second printer for receiving the combined digitized photo image and postage meter image and then printing the visual production on the substrate.

16. An apparatus as recited in claim 15 wherein said first printer is a thermal printer.

17. An apparatus as recited in claim 15 wherein said second printer is a thermal dot transfer.

18. An apparatus for producing photographs comprising:
storage means for storing postage meter indicia representing a value of postage,

camera means for viewing and capturing a viewed photographic impression,

photographic processing means for converting the viewed photographic impression into a photograph, and

means for applying the photograph and stored postage meter indicia on a substrate.

19. An apparatus as recited in claim 18 wherein said camera means includes a video camera lens and a controller board structured and disposed for viewing and receiving a video impression and for converting said received impression into a series of electrical impulses.

20. An apparatus as recited in claim 19 wherein said means for applying the photograph includes a thermal dot transfer printer.

21. An apparatus as recited in claim 18 wherein said substrate is a paper strip having an adhesive substance on one side thereof and a suitable printing surface on the opposite side.

22. A method for producing a postage meter strip comprising:

storing at least one postage meter image representing a value of postage in a data storage means,

viewing and receiving a photographic impression,

capturing said photographic impression,

combining said photographic impression with said postage meter image, and

printing said combined photographic impression and said postage meter image on a substrate.

23. A method for producing photographic image files comprising the steps of:

viewing an image with camera means and converting the viewed image into a series of electrical impulses,

capturing at least a portion of said series of electrical impulses,

digitizing said captured series of electrical impulses to create a digitized photo image,

storing said digitized photo image,

uploading said stored digitized photo image to a host computer,

storing said digitized photo image on said host computer, and

subsequently retrieving said digitized photo image for processing a document requiring a photograph.

1/4

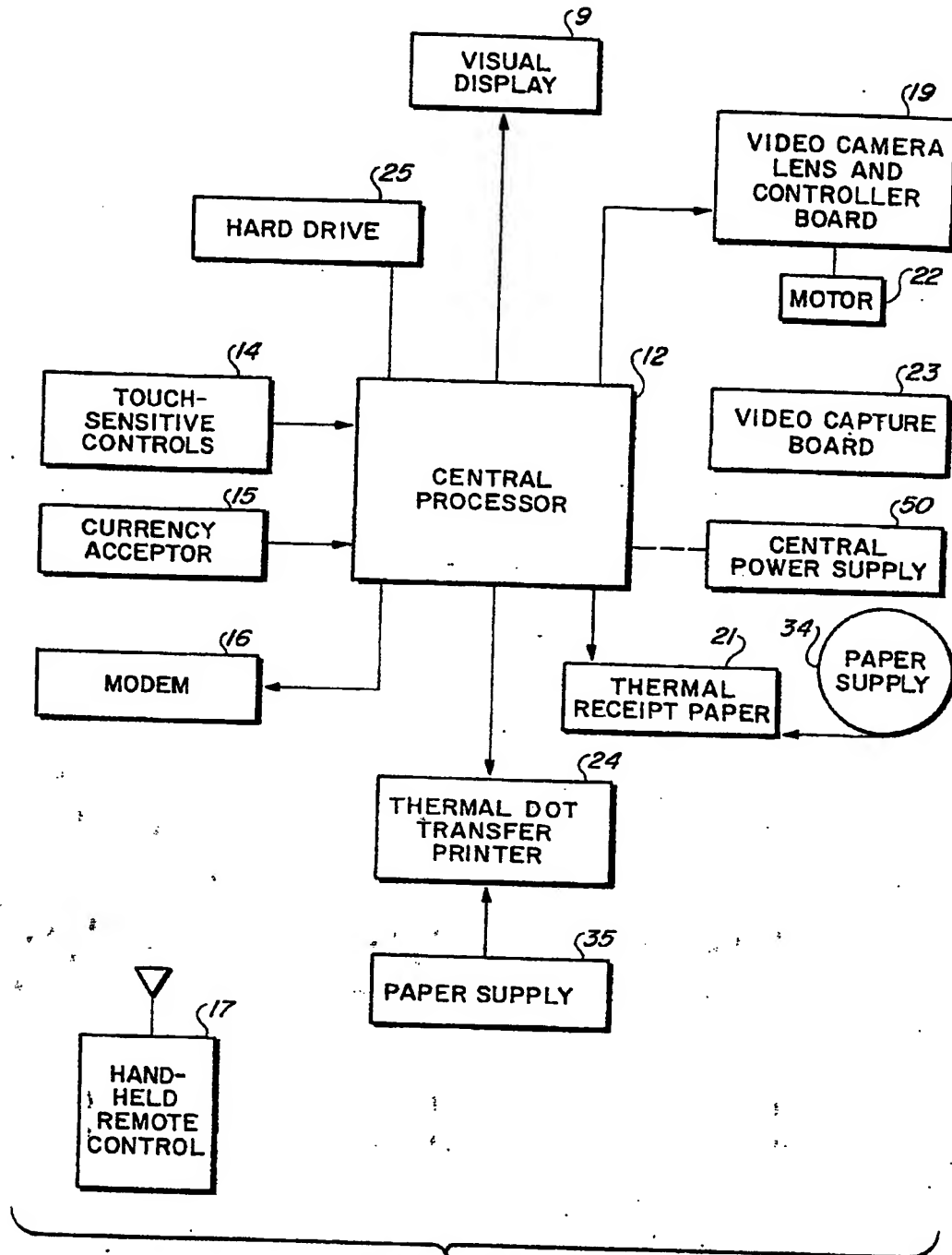
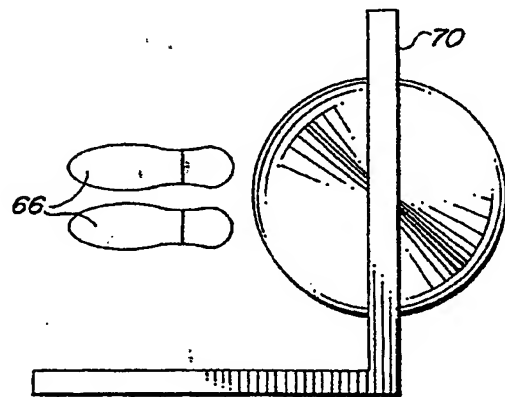
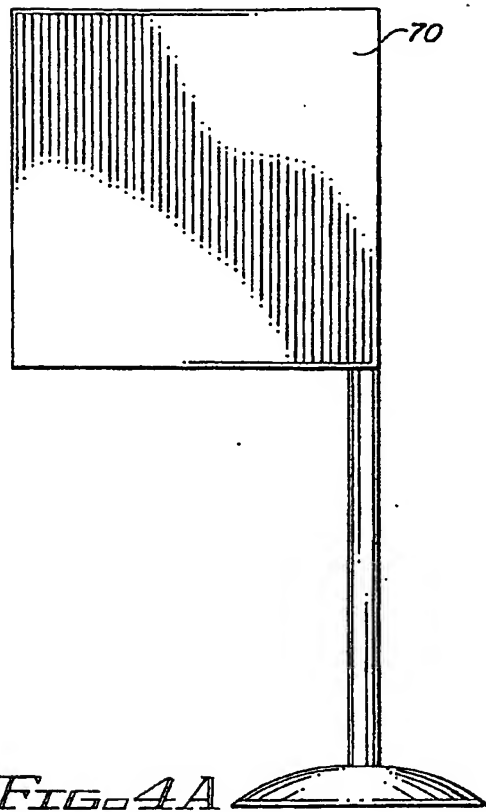
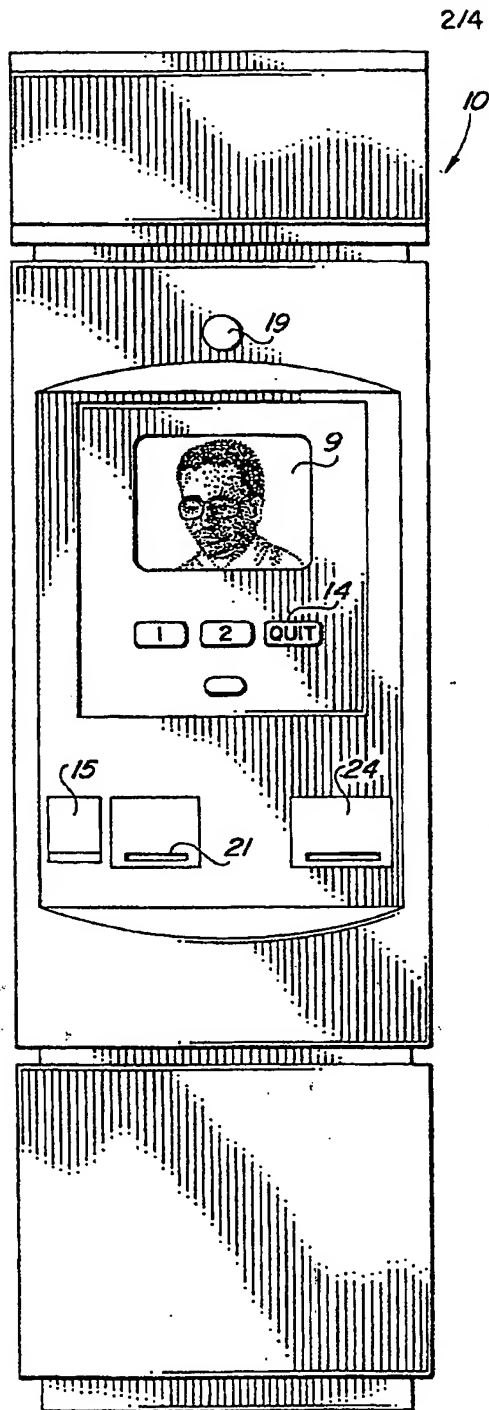


FIG. 1
SUBSTITUTE SHEET (RULE 26)



SUBSTITUTE SHEET (RULE 26)

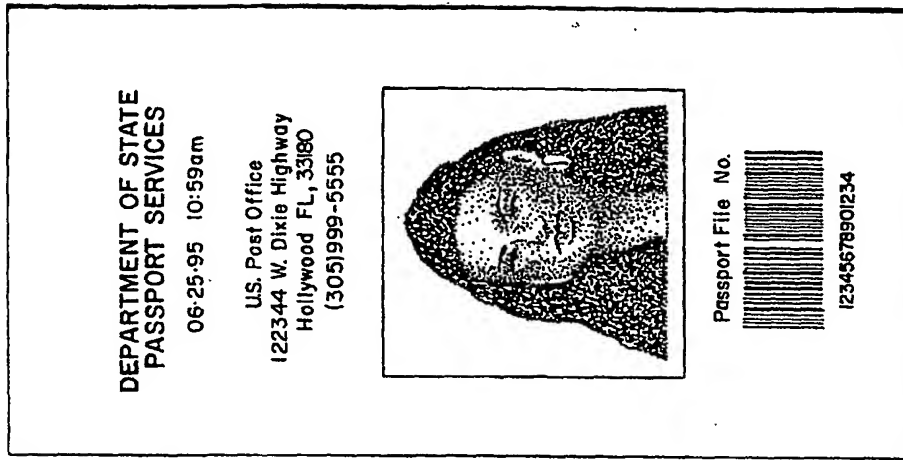


FIG. 7

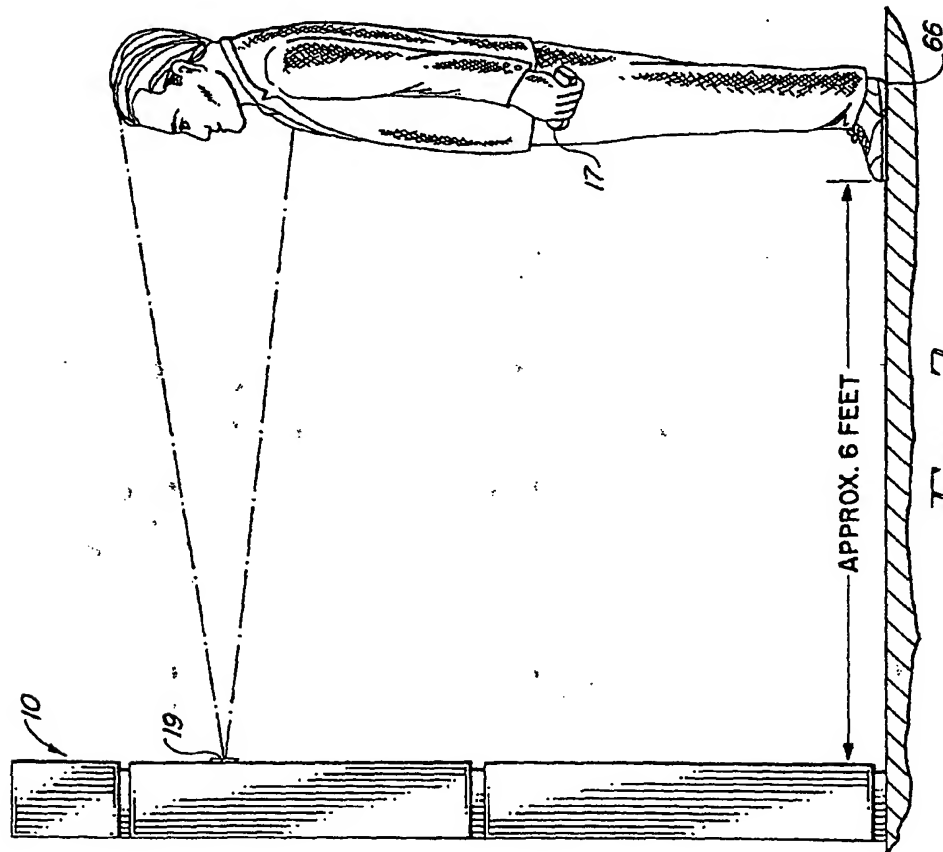
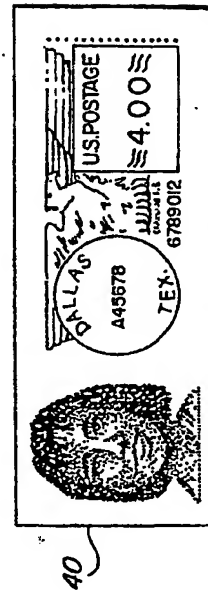
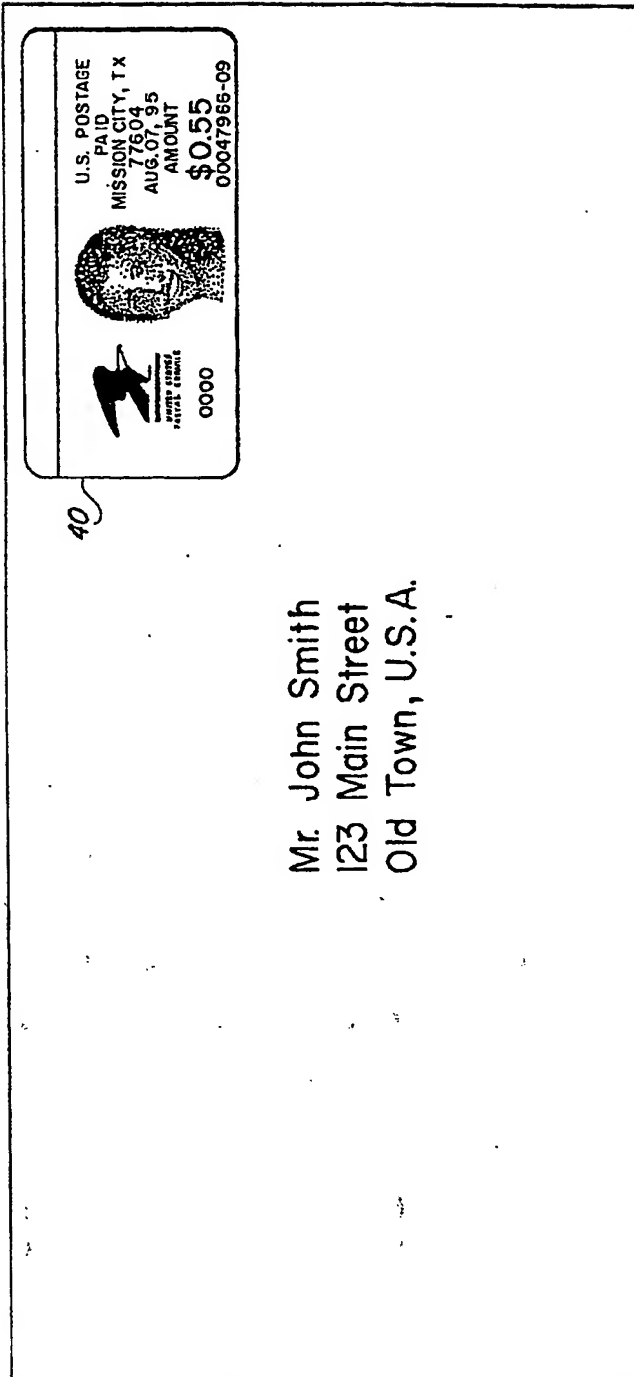


FIG. 3

SUBSTITUTE SHEET (RULE 26)



SUBSTITUTE SHEET (RULE 26)



A DOCPHOENIX

☐ TRNA _____
Transmittal New Application

☐ SPEC _____
Specification

☐ CLM _____
Claims

☐ ABST _____
Abstract

☐ DRW _____
Drawings

☐ OATH _____
Oath or Declaration

☐ ADS _____
Application Data Sheet

☐ A... _____
Amendment Including Elections

☐ A.PE _____
Preliminary Amendment

☐ REM _____
Applicant Remarks in Amendment

☐ IDS _____
IDS Including 1449

☐ 371P _____
PGT Papers in a 371P Application

☒ FOR 10 _____
Foreign Reference

☐ NPL _____
Non-Patent Literature

☐ FRPR _____
Foreign Priority Papers

☐ ARTIFACT _____
Artifact

☐ LET. _____
Misc. Incoming Letter

☐ IMIS _____
Misc. Internal Document

☐ TRREISS _____
Transmittal New Reissue Application

☐ PROTRANS _____
Translation of Provisional in Nonprovisional

☐ BIB _____
Bib Data Sheet

☐ WCLM _____
Claim Worksheet

☐ WFEE _____
Fee Worksheet

☐ APPENDIX _____
Appendix

☐ COMPUTER _____
Computer Program Listing

☐ SPEC NO _____
Specification Not in English

☐ N417 _____
Copy of EFS Receipt Acknowledgement

☐ CRFL _____
Computer Readable Form Transfer Request Filed

☐ CRFS _____
Computer Readable Form Statement

☐ SEQLIST _____
Sequence Listing

☐ SIR. _____
SIR Request

☐ AF/D _____
Affidavit or Exhibit Received

☐ DIST _____
Terminal Disclaimer Filed

☐ PET. _____
Petition

☐ END JOB☒ DUPLEX

(19)



JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **09113990 A**

(43) Date of publication of application: **02.05.97**

(51) Int. Cl. **G03B 17/53**
G03D 9/00

(21) Application number: **07288672**

(22) Date of filing: **17.10.95**

(71) Applicant: **FUJI PHOTO FILM CO LTD**

(72) Inventor: **KIMURA TSUTOMU**
AOSAKI KOU

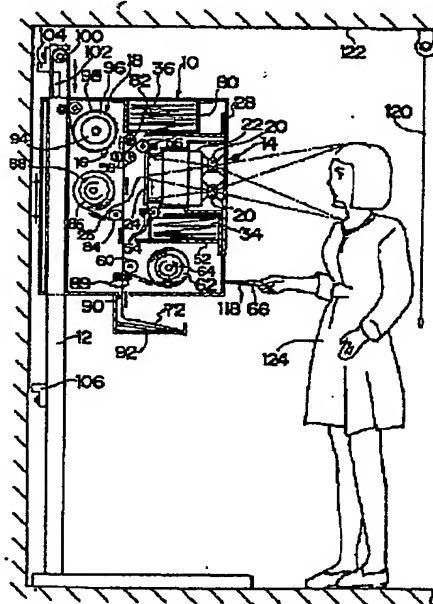
(54) DEVICE FOR TAKING PHOTOGRAPH FOR CERTIFICATE

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a device for taking a photograph for a certificate capable of obtaining an excellent-quality photograph for a certificate in a short time.

SOLUTION: A photographing camera 14 using peel apart type instant film, a printing photographic processing part 16 which cleaves the developer bag of the instant film exposed by the camera 14 and spreads developer in the developing bag between the photosensitive sheet 40 of the instant film and an image receiving sheet 72, so that a negative image recorded on the photosensitive sheet 0 is transferred on the image receiving sheet 72 as a positive image, and a feeding part 89 feeding the image receiving sheet 12 on which the positive image is transferred to the outside of a photographing unit 10 are housed in the photographing unit 10. The photographing unit 10 is moved up and down with respect to a subject by a driving part 18. Then, the camera 14, the processing part 16 and the driving part 18 are remote-controlled by a remote controller 66 so as to obtain the photograph for a certificate.

COPYRIGHT: (C)1997,JPO



(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平9-113990

(43) 公開日 平成9年(1997)5月2日

(51) Int.Cl.⁸

識別記号

庁内整理番号

F I

技術表示箇所

G 0 3 B 17/53

G 0 3 B 17/53

G 0 3 D 9/00

G 0 3 D 9/00

B

審査請求 未請求 請求項の数6 O L (全 7 頁)

(21) 出願番号

特願平7-268672

(22) 出願日

平成7年(1995)10月17日

(71) 出願人 000005201

富士写真フイルム株式会社

神奈川県南足柄市中沼210番地

(72) 発明者 木村 勤

埼玉県朝霞市泉水3丁目11番46号 富士写

真フイルム株式会社内

(72) 発明者 青崎 耕

埼玉県朝霞市泉水3丁目11番46号 富士写

真フイルム株式会社内

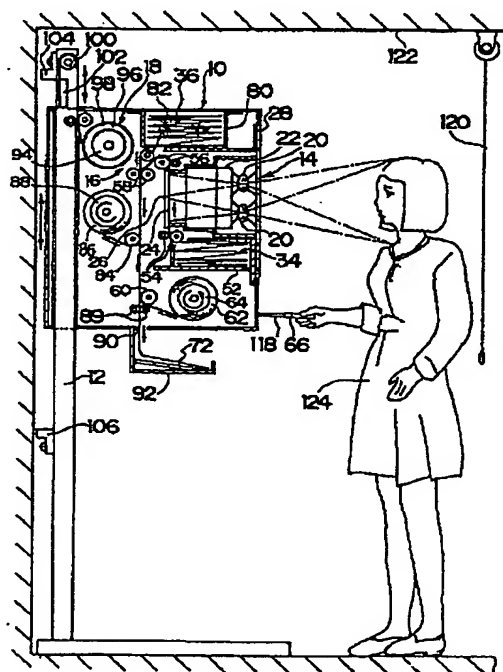
(74) 代理人 弁理士 松浦 憲三

(54) 【発明の名称】 証明写真装置

(57) 【要約】

【課題】画質の良い証明写真を短時間で得ることができる証明写真装置を提供する。

【解決手段】ヒールアパートタイプのインスタントフイルムを使用する撮影カメラ14と、撮影カメラ14で撮影された前記インスタントフイルムの現像液袋を裂開して該現像液袋内の現像液を前記インスタントフイルムの感光シート40と受像シート72との間に展開し、感光シート40に記録されたネガ像をポジ画像として受像シート72に転写させるプリント写真処理部16と、ポジ画像が転写された受像シート72を撮影ユニット10の外部に送り出す送出部89とを撮影ユニット10に収納し、この撮影ユニット10を駆動部18によって被写体に対して上下移動させる。そして、撮影カメラ14、プリント写真処理部16、及び駆動部18をリモコン装置66によってリモコン操作して証明写真を得る。



【特許請求の範囲】

【請求項1】箱体と、

前記箱体に収納され、ビールアパートタイプのインスタントフィルムを使用して被写体を撮影する撮影カメラと、

前記箱体に収納され、前記撮影カメラで撮影された前記インスタントフィルムの現像液袋を裂開して該現像液袋内の現像液を前記インスタントフィルムの感光シートと受像シートとの間に展開し、感光シートに記録されたネガ像をポジ画像として受像シートに転写させるプリント写真処理部と、

前記箱体に設けられ、ポジ画像が転写された前記受像シートを箱体の外部に送り出す送出部と、

前記箱体を被写体に対して上下移動させて被写体の撮影位置を設定する駆動部と、

前記撮影カメラ、前記プリント写真処理部、及び前記駆動部をリモコン操作するリモコン操作部と、から成ることを特徴とする証明写真装置。

【請求項2】前記撮影カメラには、少なくとも一枚の撮影レンズが設けられ、該撮影レンズによって一枚の前記インスタントフィルムに少なくとも一つ以上の被写体像を撮影することを特徴とする請求項1の証明写真装置。

【請求項3】前記撮影カメラの撮影レンズの前面にはハーフミラーが設けられ、該ハーフミラーには、被写体の撮影範囲を示す枠が形成されていることを特徴とする請求項1の証明写真装置。

【請求項4】前記箱体には、前記ビールアパートタイプのインスタントフィルムの収納部と、プリント終了後の前記感光シート、及び前記受像シートのキャリアテープを回収する回収部とが設けられていることを特徴とする請求項1記載の証明写真装置。

【請求項5】前記インスタントフィルムの収納部と、プリント終了後の前記感光シート、及び前記受像シートのキャリアテープを回収する回収部とは、前記箱体に着脱自在に装着されていることを特徴とする請求項4の証明写真装置。

【請求項6】前記箱体には、前記ビールアパートタイプのインスタントフィルムの残量を表示する表示部が設けられていることを特徴とする請求項1の証明写真装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は証明写真装置に係り、特にパスポート、免許証等の証明写真の撮影に使用される簡易型の証明写真装置に関する。

【0002】

【従来の技術】従来、パスポート、免許証等の証明写真を必要とする場合には、写真館や個人のカメラで撮影したスチール写真（ネガ・ポジによるプリント写真）を使用したり、ショッピングビルやステーションビル等に設置された簡易型の証明写真撮影ボックスでダイレクトボ

ジによるプリント写真を使用したりしている。

【0003】

【発明が解決しようとする課題】しかしながら、写真館や個人のカメラ、又は証明写真撮影ボックスで証明写真を得ようとする、撮影からスチール写真、プリント写真の完成までに時間と手間がかかるという欠点がある。本発明はこのような事情に鑑みてなされたもので、画質の良い証明写真を短時間で得ることができる証明写真装置を提供することを目的とする。

【0004】

【課題を解決するための手段】本発明は、前記目的を達成するために、箱体と、前記箱体に収納され、ビールアパートタイプのインスタントフィルムを使用して被写体を撮影する撮影カメラと、前記箱体に収納され、前記撮影カメラで撮影された前記インスタントフィルムの現像液袋を裂開して該現像液袋内の現像液を前記インスタントフィルムの感光シートと受像シートとの間に展開し、感光シートに記録されたネガ像をポジ画像として受像シートに転写させるプリント写真処理部と、前記箱体に設けられ、ポジ画像が転写された前記受像シートを箱体の外部に送り出す送出部と、前記箱体を被写体に対して上下移動させて被写体の撮影位置を設定する駆動部と、前記撮影カメラ、前記プリント写真処理部、及び前記駆動部をリモコン操作するリモコン操作部と、から成ることを特徴とする。

【0005】本発明の証明写真装置は、プリント写真を短時間で得ることができるインスタントフィルムのうち、モノシートタイプのインスタントフィルムよりも画質の良いビールアパートタイプのインスタントフィルムを証明写真として得るようにしたもので、撮影する場合には証明写真を取得したい撮影者が先ず、箱体の前方に位置する。そして、その撮影者がリモコン操作部をリモコン操作して箱体を駆動部により上下移動させて撮影カメラを自分の顔の正面に位置させる。そして、撮影者が前記操作部をリモコン操作して撮影カメラのシャッターをリリースすると、前記ビールアパートタイプのインスタントフィルムに自分の顔が記録される。この記録動作が終了すると、プリント写真処理部によって前記インスタントフィルムの現像液袋が裂開され、そして現像液袋内の現像液がインスタントフィルムの感光シートと受像シートとの間に展開されて、感光シートに記録されたネガ像がポジ画像として受像シートに転写される。そして、ポジ画像が転写された前記受像シート、即ちプリント写真は送出部により箱体外部に送り出されて撮影者に提供される。これにより、本発明では、画質の良い証明写真を短時間で得ることができる。

【0006】また、本発明では、前記撮影カメラに少なくとも一枚の撮影レンズを設けているので、シャッターをリリースすれば、一枚の前記インスタントフィルムに少なくとも一つ以上の被写体像を記録することができる。

3

更に、本発明では、前記撮影カメラの撮影レンズの前面にハーフミラーを設けているので、撮影者は自分の顔を見ながら撮影することができ、このハーフミラーに被写体の撮影範囲を示す枠を形成しているので、撮影者はその枠内に自分の顔を位置させるだけで正確な位置で撮影された証明写真を得ることができる。

【0007】本発明では、前記ビールアパートタイプのインスタントフィルムの収納部と、プリント終了後の前記感光シート、及び前記受像シートのキャリアテープを回収する回収部とが前記箱体に着脱自在に装着されており、収納部に収納されたインスタントフィルムが無くなると収納部ごと取り外し、未露光のインスタントフィルムが収納された新たな収納部を装着するようにしている。また、感光シート、及びキャリアテープの回収部に使用済みの感光シート、及びキャリアテープが溜まると回収部ごと取り外し、空の回収部を箱体に装着する。前記使用済みの感光シート、キャリアテープは、現像液によって汚れているので、回収部単位の交換を行うことにより現像液で作業者が汚れるのを防止できる。

【0008】また、本発明では、前記ビールアパートタイプのインスタントフィルムの残量を表示する表示部を箱体に設けており、この表示部の表示によりインスタントフィルムの残量、特に残量僅少を確認することができる。

【0009】

【発明の実施の形態】以下添付図面に従って本発明に係る証明写真装置の好ましい実施の形態について詳説する。図1は、本発明の実施の形態に係る証明写真装置の側断面図である。同図に示す証明写真装置は、箱型に形成された撮影ユニット10と、この撮影ユニット10を図中上下方向に昇降移動可能に案内するスタンド12とから構成される。

【0010】前記撮影ユニット10には撮影カメラ14、複数のローラから成るプリント写真処理部16、及び撮影ユニット10を上下移動させる駆動部18等が収納配置されている。前記撮影カメラ14前方の撮影ユニット10側面(図1中右側面部)は図2に示すように、矩形状の窓10Aが開口され、この窓10A内に撮影カメラ14の撮影レンズ20、20…が縦方向に2個、横方向に2個並設されている。撮影レンズ20、20…の後方には図1に示すように遮光筒22が設けられ、この遮光筒22の後部開放部、即ち露光アパーチャ24の後方には厚手のシート26が設けられている。露光アパーチャ24とシート26と間の隙間には、後述するビールアパートタイプのインスタントフィルムの感光シートユニットが給送されて位置し、この感光シートユニットの感光シートが露光アパーチャ24とシート26との間で平坦に保持された状態で露光される。また、撮影レンズ20、20…の前方には図2に示すように、ハーフミラー28が前記窓10Aに嵌め込まれて固定されている。

4

前記ハーフミラー28の略中央部には、被写体に撮影範囲を表示するフレーム28Aが形成され、このフレーム28A内に撮影レンズ20、20…が配置されている。また、ハーフミラー28の図2中右側部には、ストロボ発光部30が設けられ、また、ストロボ発光部30の下方には警告ランプ32が設けられている。この警告ランプ32は、前記ビールアパートタイプのインスタントフィルムの残量がわずかになると点灯するように制御されている。

【0011】ところで、ビールアパートタイプのインスタントフィルムは図3に示す感光シートユニット34と、図4に示す受像シートユニット36とから構成される。図3に於いて前記感光シートユニット34は、所定長さに形成された引出しシート38を先頭に複数枚の感光シート40、40…が連結シート42、42…を介して連結されて短冊状に形成されている。前記連結シート42は、表面反射を防止するために黒色をしたカーボン混抄紙等が用いられており、この連結シート42上に現像液ポッド44、現像液ポッド44から流れ出した現像液を感光シート40に向けて案内するファンネル46、及び余剰現像液を受け留めるスカート48が取り付けられている。また、連結シート42の先端部には、幅方向に山折り線50が形成されている。前記感光シートユニット34は、前記山折り線50に沿ってつづら折りされた状態で図1に示す収納箱52に収納される。この収納箱52は、撮影ユニット10に着脱自在に取り付けられ、収納箱52内に感光シートユニット34が無くなると、未露光の感光シートユニット34が収納された新たな収納箱52と交換される。

【0012】収納箱52が撮影ユニット10に取り付けられると、収納箱52に収納された感光シートユニット34は、図3に示した引出しシート38が図1に示す一対の給送ローラ54、54によって上方に送り出される。送り出された引出しシート38は、シート26と露光アパーチャ24との間の隙間を通過した後、一対の給送ローラ56、56、及び現像液ポッド44の裂開/展開用ローラ58、58(プリント写真処理部16)によって下方に送り出される。下方に送り出された引出しシート38は、ローラ60を介して巻取用ローラ62に係着される。この巻取用ローラ(回収部)62はモータ64によって回転駆動され、これにより、収納箱52に収納された感光シートユニット34が、巻取用ローラ62に巻き取られるようになっている。この巻取用ローラ62は、撮影ユニット10に着脱自在に設けられている。

【0013】前記モータ64は、撮影ユニット10にケーブル118を介して設けられたリモコン装置66(図1、図2参照)の操作によって駆動制御され、リモコン装置66のシャッターボタン68が押されると所定量回転駆動される。これにより、感光シートユニット34の感光シート40、40…が1枚目から順に露光アパーチャ

5

24の後方に位置される。また、シャッターボタン68のリリースによって、露光アパーチャ24の後方に位置された感光シート40に被写体の像が記録される。

【0014】図4に於いて受像シートユニット36は、所定長さに形成された引出しシート70を先頭に複数枚の受像シート72、72…がキャリアテープ74に貼着されて短冊状に形成されている。前記受像シート72、72…は、図3に示した感光シート40、40…の取り付け間隔と同間隔に貼着され、また受像シート72の貼着位置の前記キャリアテープ74には画面サイズに対応した矩形形状の開口部(マスク)76が形成される。また、受像シートユニット36は、キャリアテープ74に形成された山折り線78に沿ってつづら折りされた状態で図1に示す収納箱80に収納される。収納箱80は、撮影ユニット10に着脱自在に取り付けられ、収納箱80内に受像シートユニット36が無くなると、未使用の受像シートユニット36が収納された新たな収納箱80ごと交換される。

【0015】収納箱80が撮影ユニット10に取り付けられると、収納箱80に収納された受像シートユニット36は、図4に示した引出しシート70が図1に示す給送ローラ82によって下方に送り出される。送り出された引出しシート70は、前述した裂開/展開用ローラ58、58に挟持されて下方に送り出され、そしてローラ84を介して巻取用ローラ86に係着される。この巻取用ローラ86はモータ88によって回転駆動され、これにより、収納箱80に収納された受像シートユニット36が、巻取用ローラ86(回収部)に向けて巻き取られる。この巻取用ローラ86は、撮影ユニット10に着脱自在に設けられている。

【0016】前記受像シート72は、巻取用ローラ86による巻き取り中に、前記裂開/展開用ローラ58、58によって裂開された現像液ポッド44(図3参照)の現像液が、重なってきた感光シート40との間で均一な液厚で展開されることにより、感光シート40に潜像として記録されたネガ像がポジ画像として転写される。転写された前記受像シート(プリント写真)72は、前記ローラ82によってキャリアテープ74と分離される。分離されたキャリアテープ74は前記巻取用ローラ86に巻き取られ、また、分離された受像シート72は、感光シート40に付着した状態で感光シート40と共に下方に送り出される。そして、受像シート72は、ローラ60によって感光シート40と分離された後、一對の送出しローラ(送出部)89、89によって撮影ユニット10のプリント写真取出口90から受け台92に供給される。

【0017】前記モータ88は前記リモコン装置66の操作によって駆動制御され、リモコン装置66のシャッターボタン68が押されると、所定量回転駆動される。これにより、受像シートユニット36の受像シート72、

6

72…が1枚目から順に転写される。ところで、撮影ユニット10に内蔵された駆動部18は、モータ94と該モータ94によって回転駆動されるプーリ96とを有している。前記プーリ96には所定長さの堅牢なベルト98の一端が固着され、このベルト98の他端は、スタンド12の頂部に軸支されたローラ100を介してスタンド12の固定部材102に固着されている。従って、前記モータ94でプーリ96を図1の状態から時計回り方向に駆動すると、ベルト98がプーリ96から巻き戻されることにより、撮影ユニット10が自重で下降移動する。また、プーリ96を反時計回り方向に駆動すると、ベルト98がプーリ96に巻き取られることにより、撮影ユニット10がベルト98に引っ張られて上昇移動する。前記スタンド12の上部にはストッパ104が設けられ、このストッパ104に撮影ユニット10の上面部が当接することにより撮影ユニット10の上位置が規制され、また、スタンド12の下部にもストッパ106が設けられ、このストッパ106に撮影ユニット10の下面部が当接することにより撮影ユニット10の下位置が規制されている。更に、図5に示すように撮影ユニット10の側面の数カ所に、滑り部材(デルリン等のプラスチック部材)108が配置され、この滑り部材108に前記ベルト98を接触させて撮影ユニット10の昇降移動を円滑に行うようにしている。前記滑り部材108は、スプリングバネ110を介してネジ112で固定されることにより、所定の付勢力が付与された状態で撮影ユニット10に支持されている。

【0018】図1に於いて前記駆動部18のモータ94は、前記リモコン装置66(図2参照)のアップボタン114、ダウンボタン116の操作によって駆動制御される。アップボタン114が押されると、前記モータ94は図1中反時計回り方向に駆動されるので、撮影ユニット10が上昇移動される。また、ダウンボタン116が押されると、前記モータ94は図1中時計回り方向に駆動されるので、撮影ユニット10が下降移動される。

【0019】撮影ユニット10の前方には、スクリーン120が天井面122から吊り下げられている。このスクリーン120は、プリント写真の背景色を均一なトーンにするためのものである。次に、前記の如く構成された証明写真装置の使用方法について説明する。先ず、図1に示すように、証明写真を取得したい撮影者124が、撮影ユニット10とスクリーン120との間に立ち、撮影カメラ14の前方に顔を向ける。

【0020】次に、撮影者124がリモコン装置66のアップボタン114、若しくはダウンボタン116(図2参照)操作して撮影ユニット10を駆動部18により昇降移動させて撮影カメラ14を自分の顔の正面に位置させる。次に、撮影者がリモコン装置66のシャッターボタン68を押して撮影カメラ14のシャッターをリリースすると、ストロボ発光部30が発光して露光アパーチャ

24の後方に位置した感光シートユニット34の感光シート40に自分の顔が記録される。この記録動作が終了すると、感光シートユニット34がモータ64によって巻き取られると共に、受像シートユニット36がモータ88によって巻き取られる。そして、プリント写真処理部16の裂開/展開用ローラ58、58によって裂開された現像液ポッド44(図3参照)の現像液が、重なってきた感光シート40と受像シート72との間で均一な液厚で展開されて、感光シート40に潜像として記録されたネガ像がポジ画像として受像シート72に転写される。

【0021】そして、転写された受像シート(プリント写真)72は、前記ローラ84によってキャリアテープ74と分離される。分離されたプリント写真72は、感光シート40に付着した状態で感光シート40と共に下方に送り出されてローラ60により感光シート40と分離された後、送出しローラ89、89によって撮影ユニット10のプリント写真取出口90から受け台92に供給される。これにより、撮影者は、画質の良い証明写真を短時間で得ることができる。

【0022】また、プリント写真72から分離されたキャリアテープ74は巻取用ローラ86に巻き取られ、また、ローラ60によって分離された感光シート40は巻取用ローラ62に巻き取られる。本発明の証明写真装置は図2に示したように、撮影カメラ14に複数枚の撮影レンズ20、20…を並設している。従って、これらの撮影レンズ20、20…に各々設けられたシャッターを一度に、若しくは連続的にリリースすれば、一枚の感光シート40に4枚の被写体像を分けて記録することができるので、一枚の受像シート72に4枚の証明写真が同時にプリントされる。

【0023】また、本発明では、前記撮影カメラ14の撮影レンズ20、20…の前面にハーフミラー28を設けているので、撮影者124は自分の顔を見ながら撮影することができ、このハーフミラー28に撮影者の顔の撮影範囲を示すフレーム28Aを形成しているので、撮影者124はそのフレーム28A内に自分の顔を位置させるだけで正確な位置で撮影された証明写真を得ることができる。

【0024】更に、本発明では、収納箱52に収納された感光シートユニット34、及び収納箱80に収納された受像シートユニット36が無くなると収納箱52、80ごとに取り外し、未露光の感光シートユニット34、未使用の受像シートユニット36が収納された新たな収納箱52、80を撮影ユニット10に装着するようにしている。これにより、本発明では、各々のシートユニット

34、36を撮影ユニット10に容易に装着することができる。

【0025】また、本発明では、感光シートユニット34の巻取用ローラ62、及び受像シートユニット36のキャリアテープ74の巻取用ローラ86を撮影ユニット10に着脱自在に設けているので、巻取用ローラ62、86に使用済みの感光シートユニット34、キャリアテープ74が溜まると巻取用ローラ62、86ごとに取り外し、空の巻取用ローラ62、86を撮影ユニット10に装着する。前記使用済みの感光シートユニット34、キャリアテープ74は、現像液によって汚れているので、このように巻取用ローラ62、86単位の交換を行うと、現像液で作業者が汚れるのを防止できる。

【0026】また、本発明では、ピールアパートタイプのインスタントフィルムの残量を表示する警告ランプ32を撮影ユニット10に設けているので、この警告ランプ32の点灯によりインスタントフィルムの残量、特に残量僅少を確認することができる。本発明では、インスタントフィルムを使用した証明写真装置について説明したが、35mmフィルムを使用しても良い。

【0027】

【発明の効果】以上説明したように本発明に係る証明写真装置によれば、プリント写真を短時間で得ることができるインスタントフィルムのうち、モノシートタイプのインスタントフィルムよりも画質の良いピールアパートタイプのインスタントフィルムを使用したので、画質の良い証明写真を短時間で得ることができる。

【図面の簡単な説明】

【図1】本発明の実施の形態に係る証明写真装置の側断面図

【図2】図1に示した証明写真装置の撮影ユニットの正面図

【図3】感光シートユニットの斜視図

【図4】受像シートユニットの斜視図

【図5】箱体の上下移動を円滑に行うための要部機構図

【符号の説明】

10…撮影ユニット

12…スタンド

14…撮影カメラ

16…プリント写真処理部

18…駆動部

20…撮影レンズ

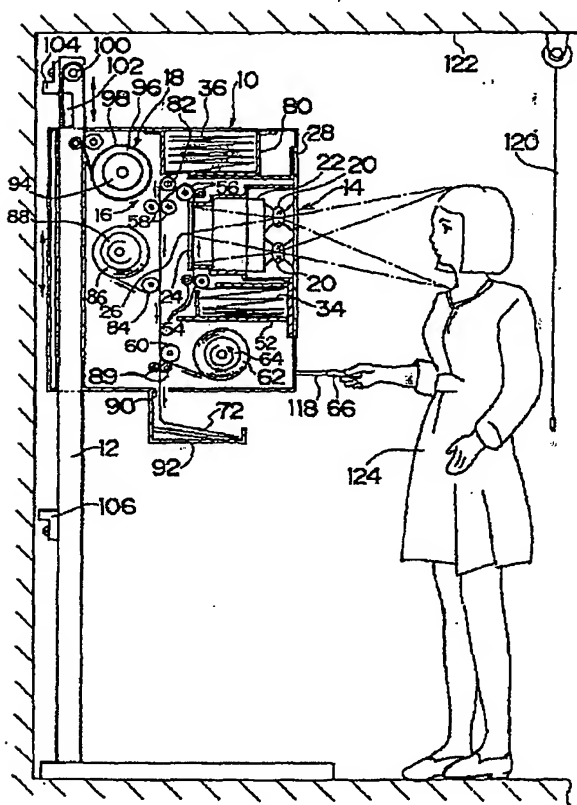
28…ハーフミラー

34…感光シートユニット

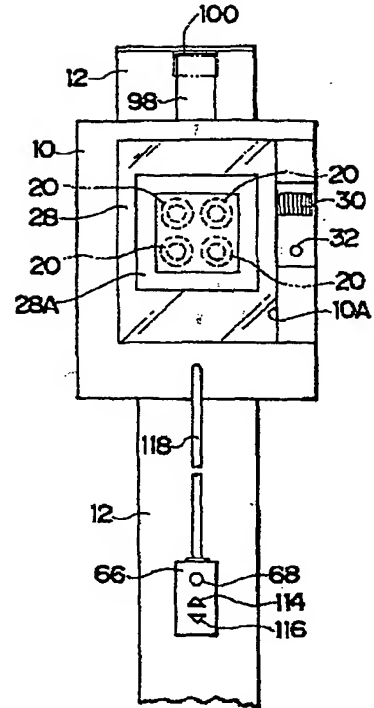
36…受像シートユニット

66…リモコン装置

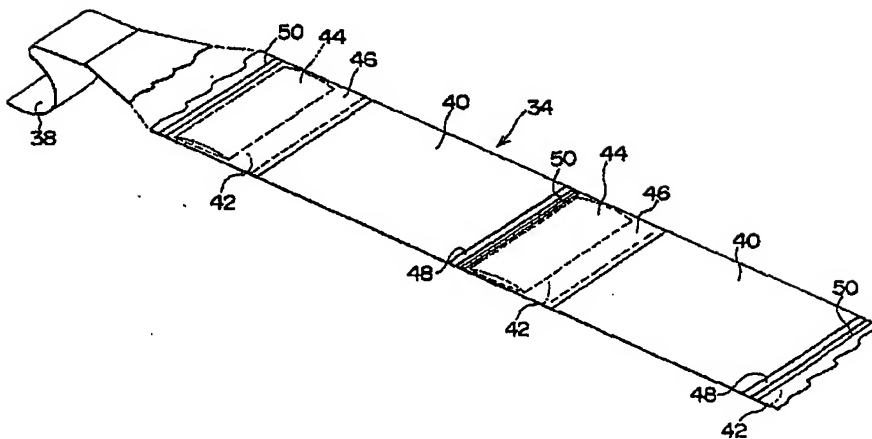
【図1】



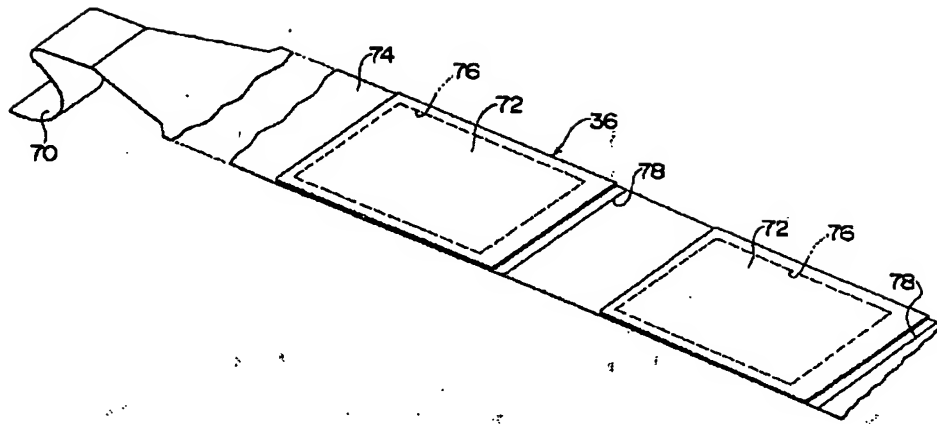
【図2】



【図3】



【図4】



【図5】

